

TRANSPORTATION
LIBRARY
TJ
685
.458
1945

B 726,121 DUPL

TM 55-270

WAR DEPARTMENT TECHNICAL MANUAL

OPERATION OF RAILROADS
GENERAL INSTRUCTIONS
FOR THE INSPECTION AND
MAINTENANCE OF
LOCOMOTIVES
AND LOCOMOTIVE CRANES

WAR DEPARTMENT • APRIL 1945

Digitized by Google

UNIVERSITY OF MICHIGAN LIBRARIES
UNIVERSITY OF MICHIGAN

WAR DEPARTMENT TECHNICAL MANUAL

TM 55-270

This manual supersedes TB 55-270-1, 27 July 1944; TB 55-270-2, 8 August 1944; TB 55-270-3, 24 August 1944; and TB 55-270-4, 23 August 1944.

OPERATION OF RAILROADS

GENERAL INSTRUCTIONS

FOR THE INSPECTION AND

MAINTENANCE OF LOCOMOTIVES

AND LOCOMOTIVE CRANES



WAR DEPARTMENT

• APRIL 1945

United States Government Printing Office

Washington : 1945

Transportation

Library

TJ

685

458

1945

WAR DEPARTMENT
Washington 25, D.C., 30 April 1945

TM 55-270, Operation of Railroads, General Instructions for the Inspection and Maintenance of Locomotives and Locomotive Cranes, is published for the information and guidance of all concerned.

[AG 300.7 (31 Jan. 45)]

BY ORDER OF THE SECRETARY OF WAR:

OFFICIAL:

J. A. ULIO
Major General
The Adjutant General

G. C. MARSHALL
Chief of Staff

DISTRIBUTION:

AAF (5); AGF (5); ASF (2); T of Opns (5); Dept (2); Base Comd (2);
Arm & Sv Bd (2); S Div ASF (1); Tech Sv (2); Sv C (2); PE (5);
H & R (2); TZ (2); USMA (2); TCRRS (5); T/OE 55-202(10); 55-
225(50); 55-228(25); 55-229(50); 55-235(10); 55-236(5); 55-237(30);
55-238(30); 55-302(25); 55-500, 11-Railroad Maint Units (5); V11-Train
Opr Units (5).

Refer to FM 21-6 for explanation of distribution formula.

CONTENTS

	<i>Paragraphs</i>	<i>Page</i>
CHAPTER 1. GENERAL INSTRUCTIONS	1-6	1
CHAPTER 2. ECHELONS OF MAINTENANCE	7-12	3
CHAPTER 3. WATER TREATMENT	13	5
CHAPTER 4. REGULATIONS GOVERNING INSPECTION AND TESTING OF STEAM LOCOMOTIVES.		
<i>Section I.</i> Boilers and their appurtenances.....	14-25	6
<i>II.</i> Brake equipment	26-35	9
<i>III.</i> Cabs, warning signals, and sanders.....	36-40	11
<i>IV.</i> Drawgear, draft gear, driving gear, and running gear.....	41-43	11
<i>V.</i> Wheels	44-48	13
<i>VI.</i> Lights	49-52	15
<i>VII.</i> Throttle and reversing gear; ash pans.....	53-55	16
<i>VIII.</i> Tenders	56-59	16
<i>IX.</i> Reports	60-61	16
CHAPTER 5. INSPECTION AND MAINTENANCE OF STEAM LOCOMOTIVES.		
<i>Section I.</i> Basic principles	62-63	17
<i>II.</i> Firing locomotives	64-65	18
<i>III.</i> Feedwater control and boiler maintenance.....	66-67	20
<i>IV.</i> Machinery maintenance, lubrication, and inspection.....	68-72	22
<i>V.</i> Locomotives out of service	73-76	25
CHAPTER 6. REGULATIONS GOVERNING INSPECTION AND TESTING OF LOCOMOTIVES, OTHER THAN STEAM.		
<i>Section I.</i> Brake equipment	77-84	28
<i>II.</i> Drawgear and running gear	85-86	29
<i>III.</i> Wheels	87-89	32
<i>IV.</i> Cabs, lights, whistles, bells, sanders, and signals.....	90-92	33
<i>V.</i> Electrical equipment	93-108	34
<i>VI.</i> Internal combustion equipment	109-114	36
<i>VII.</i> Boilers	115-142	37
<i>VIII.</i> Reports	143-144	41
CHAPTER 7. DIESEL-ELECTRIC LOCOMOTIVES.		
<i>Section I.</i> General	145-146	49
<i>II.</i> Operation of locomotive	147-168	50
<i>III.</i> Maintenance of locomotive	169-177	54
<i>IV.</i> Inspection of locomotive	178-183	57
<i>V.</i> Locomotives out of service	184-187	58
CHAPTER 8. LOCOMOTIVE CRANES, DERRICKS, AND PILE DRIVERS.....	188-193	60

	<i>Paragraphs</i>	<i>Page</i>
CHAPTER 9. GASOLINE-MECHANICAL LOCOMOTIVES	194-200	65
CHAPTER 10. OPERATION AND MAINTENANCE OF AUTO- RAILERS	201-203	68
CHAPTER 11. SURFACE MAINTENANCE	204	70
CHAPTER 12. OPERATING AND INSPECTION REPORT FORMS	205-226	71
APPENDIX I. VACUUM BRAKE AND COMBINED VACUUM AND AIR BRAKE EQUIPMENT FOR LOCOMOTIVES.....		101
APPENDIX II. CONDEMNING LIMITS FOR MOTOR-DRIVEN AIR COMPRESSORS		103
APPENDIX III. NUMERICAL INDEX OF REGULATIONS GOVERNING INSPECTION AND TESTING OF STEAM LOCOMOTIVES (CH. 4)		112
APPENDIX IV. NUMERICAL INDEX OF REGULATIONS GOVERNING INSPECTION AND TESTING OF OTHER THAN STEAM LOCOMOTIVES (CH. 6)		114
INDEX.....		117

CHAPTER I

GENERAL INSTRUCTIONS

1. Purpose

The purpose of this manual is to give personnel concerned with the operation and maintenance of locomotives, locomotive cranes, and pile drivers, pertinent regulations and proper procedures governing the inspection and maintenance of such equipment. It is intended as a guide for engineers, firemen, and maintenance crews, providing information and instructions for carrying out their duties and discharging their responsibilities.

2. Scope

This manual outlines procedures for necessary inspection and proper maintenance by trained personnel familiar with locomotive construction and repair. It outlines *what* to do, *where* to do it, and *when* it will be done; it is beyond the scope of this manual to include *how* such repairs will be made. Necessary report forms with instructions in their use are included. Regulations set up in this manual will be more generally applicable to the zone of interior, but when and where conditions permit, the information contained herein will serve as a guide for theaters of operations. Because of the number of different types and sizes of government-owned steam, Diesel-electric, Diesel-mechanical, gasoline-mechanical and gasoline-electric locomotives, cranes, and pile drivers, it is impossible to treat in great detail the operation and maintenance of this equipment. All officers and enlisted men will acquaint themselves with the proper War Department Technical Manuals issued for instruction and guidance on the specific pieces of equipment under their jurisdiction. (See FM 21-6.)

3. Personnel

Efficiency rating of personnel concerned with the operation and maintenance of locomotives and locomotive cranes is based upon: the appearance and mechanical efficiency of the equipment; the manner in which inspection and maintenance duties are performed; the economical and efficient use of fuels, supplies, materials, and lubricants; and the period for which the equipment is maintained in good operating condition without requiring extensive repairs

or general overhauling. Locomotive and crane crews will study and be familiar with War Department publications relating to the specific equipment in their charge; if further information is needed, application will be made in the zone of interior to the zone transportation officer, Attention of the zone master mechanic, and in a theater of operations to the superintendent of equipment, railway grand division headquarters. Requests will give the serial number and type of equipment for which information is desired.

4. Responsibilities

a. Officers in charge of War Department railroad equipment will familiarize themselves with appropriate Army regulations covering liability of responsible officers in case of damage to or destruction of Government property (AR 35-6640).

b. ZONE OF INTERIOR. The chief of transportation, through the zone master mechanics, is responsible for the technical control of the operation, inspection, maintenance and repair of War Department railroad equipment, except contractor operated railroad equipment in class IV establishments where maintenance, inspection and repair is carried out in accordance with provisions of pertinent War Department directives and Army Regulations. Technical control of maintenance is the authority to issue instructions covering the utilization of equipment, tools, shop methods, shop lay-outs and procedures, and detailed directives to insure uniformity of quality, as applicable to the items maintained.

c. TERRITORIAL DEPARTMENTS. In territorial departments and commands (such as the Eastern Defense Command, Panama Canal Department, and Hawaiian Department) the commanding general of the department or command is responsible for the operational control of inspection, maintenance and repair of War Department railroad equipment which is not operated by a unit of the military railway service. Operational control embraces the organization, administration, management, and operation of repair shops in accordance with prescribed procedures, including the formulation of working procedures other than those specified by higher authority or developed in connection with technical control.

The commanding generals of territorial departments and commands may call upon the Chief of Transportation for assistance in the discharge of these responsibilities.

d. THEATERS OF OPERATIONS. The superintendent of equipment, railway grand division headquarters, is responsible for both technical and operational control of, inspection, maintenance and repair of War Department railroad equipment within their division.

e. Interstate Commerce Commission's rules and regulations as to operation and maintenance of equipment do not apply to War Department railroad equipment on Government property. However, should items of equipment be offered in interchange and be handled by common carrier, all I.C.C. rules will govern them. The zone master mechanic will have a thorough knowledge of all rules and regulations governing such interchange and will be responsible for compliance therewith by all personnel concerned. Copies of all interchange rules may be obtained from the Chief of Transportation.

5. Lubrication

Personnel concerned with the maintenance of locomotives and locomotive cranes and pile drivers will be governed by War Department Lubrication Orders and will requisition all lubricants in accordance

with the nomenclature, stock numbers, and specifications contained in War Department Supply Bulletin No. 10-139. In case there are no Government standard specifications for a particular requirement, the order will be based on instructions issued by an authorized officer.

6. Safety

Safety is of primary importance in the discharge of duty. All personnel will read, understand, and follow regulations and instructions set forth in TM 55-281 (when published), a copy of which will be carried for reference while on duty. Personnel will not rely upon the watchfulness of others but will protect themselves where their own safety is involved. Any unsafe condition or practice will be reported immediately to the officer in charge. Personnel who knowingly persist in practices which are unsafe are subject to disciplinary action whether such conduct is regulated by rule or otherwise. Personnel will not be required or expected to take risks from which they cannot protect themselves by care and judgment. Injury of any kind, however trivial, will be reported promptly to the immediate superior, medical attention obtained when necessary, and the proper entry made in the Daily Sick Report (WD AGO Form 5). (For first aid see FM 21-11.)

ECHELONS OF MAINTENANCE

7. General

a. The maintenance operations of the Transportation Corps follow the five echelon system.

b. **ZONE OF INTERIOR.** Commanding officers of installations where locomotives and locomotive cranes are operated or domiciled are responsible for first and second echelon maintenance of this equipment. The chief of transportation is responsible for the third, fourth, and fifth echelon maintenance. Zone master mechanics, as representatives of the chief of transportation, exercise technical control over all echelons of maintenance of War Department railroad equipment operated or domiciled at installations within the area of their respective zones.

c. **THEATERS OF OPERATIONS.** (1) "C" Company of an operating battalion is responsible for first echelon maintenance.

(2) "B" Company of an operating battalion is responsible for second and fixed third echelon maintenance.

(3) Mobile railway workshop is responsible for third echelon maintenance (mobile).

(4) Railway shop battalion is responsible for fourth and fifth echelon maintenance.

Note. The Military Railway Service may supplement the above maintenance operations by utilizing to the maximum existing civilian personnel and equipment.

d. In territorial departments, the echelons of maintenance are similar to those in the zone of interior. (See par. 4*c* for exceptions.)

8. First-Echelon Maintenance

First-echelon maintenance in both zone of interior and in theaters of operations consists primarily of preventive maintenance and will include inspection of moving parts, lubrication, and minor adjustments. It will be performed by the engineman, operator, or messenger and his assistants.

9. Second-Echelon Maintenance

a. **ZONE OF INTERIOR.** Second-echelon maintenance consists of preventive maintenance measures such as inspection, adjustments, replenishing of lubricants, fuel, water, sand, and other necessary supplies,

and such minor repairs as replacing headlight bulbs, applying new brake shoes and air brake hose, and adjusting brakes. It will include application tests of air brake equipment, inspection of engine for fuel and lubricating oil leaks, inspection of running gear, boiler wash-outs, and such repairs as may be accomplished locally without the use of elaborate machine tools or heavy machinery. Second-echelon maintenance will be performed by maintenance personnel at the installations where the equipment is operated or domiciled.

b. **THEATERS OF OPERATIONS.** Second-echelon maintenance is equivalent to the operations of a rail roundhouse. In addition to measures in *a* above it will include the maintenance functions shown in paragraph 10*a* for the third echelon in the zone of interior.

10. Third-Echelon Maintenance

a. **ZONE OF INTERIOR.** Third-echelon maintenance consists of such repairs as are normally beyond the scope of local facilities or maintenance personnel and which require taking a locomotive or locomotive crane out of service for a definite period of time. It will include repairs to or removal of parts which are in such condition as to interfere with efficient and successful operation of, or performance by, the equipment, such as repairs to running gear necessitated by normal wear, repairs to lubricating and fuel systems, removal of wheels for turning, repairs to flues and tubes, and other repairs requiring only partial dismantling of the equipment. Third-echelon repairs will be made by Transportation Corps railroad repair shops, or by common carrier railroad repair shops when so authorized by the chief of transportation or the zone transportation officer having jurisdiction over maintenance of the equipment, except that installations having adequate facilities therefor will make third echelon repairs upon instructions from the chief of transportation or the zone master mechanic.

b. **THEATERS OF OPERATIONS.** Third-echelon maintenance includes any repairs necessary to restore damaged railroad equipment to operation on the railroad right-of-way or for movement to a fixed in-

stallation for proper repairs. Such repairs normally will be performed by a railway mobile workshop in the forward areas. If the damage is not too great, this unit may repair the equipment for service. In rear areas, fixed third-echelon maintenance will be performed by "B" company of an operating battalion.

11. Fourth-Echelon Maintenance

a. ZONE OF INTERIOR. Fourth-echelon maintenance consists of heavy repairs requiring the use of heavy machinery and tools. Such repairs will be made by Transportation Corps railroad repair shops, or by common carrier railroad repair shops when so authorized by the chief of transportation or the zone transportation officer having jurisdiction over maintenance of the equipment, except that installations having adequate facilities therefor will make fourth echelon repairs upon instructions from the chief of transportation or zone master mechanic.

b. THEATERS OF OPERATIONS. Fourth-echelon maintenance can be performed only by a railway shop battalion at a fixed installation and is equivalent

to the operation of a railroad *general* repair shop. It will include reconditioning; rebuilding of motive power; application of a new boiler, or back end, turned or new tires, new or reset flues; rebuilding or overhauling of engines; repairs to electrical apparatus; and all necessary repairs to machinery.

12. Fifth-Echelon Maintenance

a. ZONE OF INTERIOR. Fifth-echelon maintenance consists of complete rebuilding of a locomotive or locomotive crane, and will be performed by Transportation Corps railroad repair shops, or by common carrier railroad repair shops when so authorized by the chief of transportation or the Zone transportation officer having jurisdiction over maintenance of the equipment.

b. THEATERS OF OPERATIONS. Fifth-echelon maintenance is service maintenance performed in rear areas utilizing fixed installations to recondition equipment completely, incorporating reclamation and limited manufacture, and will be performed by the railway shop battalion.

WATER TREATMENT

13. Water Treatment

a. In theaters of operations the chemical engineer of a railway grand division will survey and analyze all water facilities for railroad use when entering new territories. In the zone of interior the zone master mechanic will obtain samples of such water and forward them to the proper authorities for analysis.

b. After consulting with the superintendent of equipment in the theater of operations or chief of transportation in the zone of interior, responsible authority will issue instructions immediately regarding feedwater treatment of locomotive, locomotive crane boilers, and internal combustion engine cooling systems used by the Transportation Corps.

c. For the purpose of ascertaining that proper treatment is used at all times, analysis of water facilities must be seasonal or at any such time as water conditions change. Copies of analysis and instruc-

tion will be submitted to the chief of transportation or to the railway grand division headquarters for approval and additional recommendations.

d. The type of water treatment approved in each theater by the superintendent of equipment, railway grand division headquarters, and by the chief of transportation for the zone of interior will be maintained at a location convenient for application. A calibrator measuring stick will be made available at a suitable location to enable the proper amount of treatment to be added when water supply is replenished.

e. In the zone of interior, requisitions for specimen bottles for taking periodic samples of feedwater will be made to the chief of transportation. Complete instructions will be given to the commanding officer of each installation as to initial and continuing phases of treatment. The number of locomotives and locomotive cranes at the installation will be entered on each requisition.

REGULATIONS GOVERNING INSPECTION AND TESTING OF STEAM LOCOMOTIVES

Section I. BOILERS AND THEIR APPURTENANCES

14. Responsibility (Rule No. 1)

The mechanical officer in charge at each point where boiler work is done will be responsible for the inspection and repair of all locomotive boilers and their appurtenances under his jurisdiction. No locomotive will be returned to service until all defects disclosed by any inspection are corrected.

15. Inspection of Interior of Boilers

a. TIME OF INSPECTION (RULE No. 2). The interior of each boiler will be inspected thoroughly before the boiler is put into service, except when it is new, and whenever a sufficient number of flues are removed to allow examination.

b. REMOVAL OF FLUES (RULE No. 3). (1) All flues of locomotive boilers in service will be removed at least once every 4 years for thorough examination of the entire interior of the boiler and its bracing.

(2) The flues will be removed after 48 calendar months' service, provided such service is performed within 5 consecutive years. Portions of calendar months out of service will not be counted. Time out of service must be accounted for properly by out of service reports; notations of months claimed out of service will be made on the back of each subsequent inspection report and cab card.

(3) After the flues are taken out, all foreign matter will be removed from the inside of the boiler, the boiler cleaned thoroughly and inspected.

(4) If investigation shows that conditions warrant, the period for removal of flues may be extended upon formal application to the railway grand division headquarters in theaters of operation, or to the Chief of Transportation in the zone of the interior. Formal application will be submitted approximately 30 days before the work is due in order that a proper investigation may be made before the flues are delinquent.

c. METHOD OF INSPECTION (RULE No. 4). The entire interior of the boiler will be examined for

cracks, pitting, grooving, or indications of overheating and for damage where mud has collected or a heavy accumulation of foreign matter has formed. The edges of plates, and all laps, seams, and points where cracks or other defects are likely to develop will be given a minute examination. Care will be taken to see that braces and stays are taut, that pins are secured properly in place, and that each is in condition to support its proportion of the load.

d. REPAIRS (RULE No. 5). Any boiler which develops cracks in the barrel will be taken out of service immediately, repaired properly, and reported to be in satisfactory condition before it is returned to service.

e. LAP-JOINT SEAMS (RULE No. 6). Every boiler with lap-joint longitudinal seams without reinforcing plates will be examined carefully to detect grooving or cracks at the edges of the seams.

f. FUSIBLE PLUGS (RULE No. 7). If boilers are equipped with fusible plugs they will be removed and cleaned of scale at least once every month. Their removal must be noted on the report of inspection.

16. Inspection of Exterior of Boiler

a. TIME OF INSPECTION (RULE No. 8). The exterior of every boiler will be inspected thoroughly before the boiler is put into service, except when it is new, and whenever the jacket and the lagging are removed.

b. LAGGING TO BE REMOVED (RULE No. 9). The jacket and lagging will be removed at least once every 5 years and a thorough inspection made of the entire exterior of the boiler while under hydrostatic pressure.

17. Testing Boilers

a. TIME OF TESTING. (1) *Boilers in service (Rule No. 10).* After each 12 months of service, all boilers except these out of service (see (2) below) will be subjected to a hydrostatic pressure of 25 percent above the working steam pressure. Per-

sonnel concerned in these tests will not permit the application of any pressures greater than that specified.

(2) *Boilers out of service (Rule No. 11)*. Boilers will be inspected as prescribed in AR 850-300. When the annual inspection is made at a common carrier railroad shop or at an Army railroad repair shop, a monthly inspection is neither required nor desired for the month in which the annual inspection is made. A locomotive stored when a hydrostatic test becomes due need not be given such test until immediately prior to its being returned to service. Boilers out of service in the zone of interior will be reported once each month to the interested zone master mechanic who will forward this information to the chief of transportation. Boilers out of service in theaters of operations will be reported each month to the railway grand division headquarters in the theater.

b. REMOVAL OF DOME CAP (RULE No. 12). The dome cap and throttle standpipe will be removed at the time of making the hydrostatic test and the interior surface and connections of the boiler examined as thoroughly as conditions will permit. In case the boiler can be entered and inspected thoroughly without removing the throttle standpipe, the inspector may make the inspection by removing only the dome cap. Any variation from the rule will be noted in the report of inspection.

c. REPAIRS AND STEAM TEST (RULE No. 13). When all necessary repairs have been completed, the boiler will be fired up, the steam pressure raised to not less than the allowed working pressure and the boiler and appurtenances examined carefully. All cocks, valves, seams, bolts, and rivets must be tight under this pressure and all defects disclosed will be repaired.

18. Staybolt Testing

a. TIME OF TESTING RIGID BOLTS (RULE No. 14). All staybolts will be tested at least once each month. Staybolts also will be tested immediately after every hydrostatic test.

b. METHOD OF TESTING RIGID BOLTS (RULE No. 15). The inspector will tap each bolt and determine the broken bolts from the sound or the vibration of the sheet. If staybolt tests are made when the boiler is filled with water, there must be not less than 50 pounds pressure in the boiler. Should the boiler not be under pressure, the test may be made after draining all water from the boiler, in which case the vibration of the sheet will indicate any unsoundness. The latter test is preferable.

c. METHOD OF TESTING FLEXIBLE STAYBOLTS

WITH CAPS (RULE No. 16). (1) Except as provided in (2) below all staybolts having caps over the outer ends will have the caps removed at least once every 2 years and the bolts and sleeves examined for breakage. Each time the hydrostatic test is applied, the hammer test required by rules No. 14 and 15 will be made while the boiler is under hydrostatic pressure of not less than the allowed working pressure.

(2) Certain types of flexible staybolts are provided with a telltale hole not less than $\frac{3}{16}$ inch nor more than $\frac{7}{32}$ inch in diameter. This hole extends the entire length of the bolt and into the head not less than $\frac{1}{3}$ of its diameter, and is protected by copper plating from becoming closed by corrosion. If it is opened each time the hydrostatic test is applied and tested by means of an approved electrical or other instrument, such action positively will indicate when the telltale holes are open their entire length and it will not be necessary to remove the caps. When this test is completed, the hydrostatic test will be applied and all staybolts which show leakage through the telltale hole will be removed.

(3) When locomotives are in service the inner ends of the telltale holes will be kept closed with a fireproof, porous material. This excludes foreign matter and permits leakage of steam or water into the telltale hole in event the bolt is broken or fractured.

(4) The removal of flexible staybolt caps and other tests will be reported on WD AGO Form 55-239 (see ch. 12), and a proper record kept of the inspections and tests.

(5) Fire box sheets will be examined carefully at least once every month for mudburn, bulging, and indication of broken staybolts.

(6) Staybolt caps will be removed, or any of the above tests made, whenever the chief of transportation in the zone of interior or the railway grand division headquarters in a theater of operations, considers it desirable in order to determine the condition of staybolts or staybolt sleeves.

d. METHOD OF TESTING FLEXIBLE STAYBOLTS WITHOUT CAPS (RULE No. 17). Flexible staybolts which do not have caps will be tested once each month the same as rigid bolts. Each time a hydrostatic test is applied such staybolt test will be made while the boiler is under hydrostatic pressure of not less than the allowed working pressure and proper notation of such test will be made on WD AGO Form 55-239. (See ch. 12.)

e. BROKEN STAYBOLTS (RULE No. 18). No boiler will be allowed to remain in service when there are two adjacent staybolts broken or plugged in any part

of the fire box or combustion chamber, nor when three or more are broken or plugged in a circle 4 feet in diameter, nor when five or more are broken or plugged in the entire boiler.

f. TELLTALE HOLES (RULE No. 19). All rigid staybolts must have telltale holes of $\frac{3}{16}$ inch or $\frac{7}{32}$ inch in diameter with the length not less than $1\frac{1}{4}$ inches at the outer end. These holes will be maintained in a clean condition.

g. DRILLING TELLTALE HOLES (RULE No. 20). All staybolts shorter than 8 inches (except flexible bolts), and rigid bolts behind frames and braces, which do not have telltale holes, will be drilled when the locomotive is in the shop for heavy repairs.

19. Steam Gauges

a. LOCATION OF GAUGES (RULE No. 21). Every boiler will have at least one steam gauge which will indicate correctly the working pressure. Care will be taken to locate the gauge so that it will keep reasonably cool and can be read conveniently by the enginemen.

b. SIPHON (RULE No. 22). Every gauge will have a siphon made of copper tubing of ample capacity to prevent steam from entering the gauge. The pipe connection will enter the boiler direct and will be maintained steam tight between boiler and gauge. The siphon pipe and its connections to the boiler will be cleaned each time the gauge is tested.

c. TIME OF TESTING (RULE No. 23). Steam gauges will be tested at least once every 3 months and also when any irregularity is reported.

d. METHOD OF TESTING (RULE No. 24). Steam gauges will be compared with an accurate test gauge or dead weight tester; gauges found inaccurate will be corrected before being placed in service.

e. BADGE PLATES (RULE No. 25). A metal badge plate showing the allowed steam pressure will be attached to the boiler head in the cab. If boiler head is lagged, the lagging and jacket will be cut away so that the plate can be seen.

f. BOILER NUMBER (RULE No. 26). The builder's number of the boiler, if known, will be stamped on that dome. If the builder's number of the boiler cannot be obtained, an assignment number to be used in making out specification cards will be stamped on the dome. The number will be stamped horizontally on the front side of the dome near the top, with figures at least $\frac{3}{8}$ inch high.

20. Safety Valves

a. NUMBER AND CAPACITY (RULE No. 27). Every boiler will be equipped with at least two safety valves, the capacity of which will be sufficient to

prevent, under any conditions of service, an accumulation of pressure more than 5 percent above the allowed steam pressure.

b. SETTING OF SAFETY VALVES (RULE No. 28). Safety valves will be set to pop at pressures not exceeding 6 pounds above the working steam pressure. When safety valves are set, two steam gauges will be used one of which will be so located that it will be in full view of the person engaged in setting such valves; if the pressure indicated by the gauges varies more than 3 pounds the gauges will be removed from the boiler, tested, and corrected before the safety valves are set. Gauges in all cases will be tested immediately before the safety valves are set or any change made in the setting. When safety valves are being set, the water level in the boiler will not be above the highest gauge cock.

c. TIME OF TESTING (RULE No. 29). Safety valves will be tested under steam at least once every 3 months, and also when any irregularity is reported.

21. Water Glass and Gauge Cocks

a. NUMBER AND LOCATION (RULE No. 30). Every boiler will be equipped with at least one water glass and three gauge cocks. The lowest gauge cock and the lowest reading of the water glass will not be less than 3 inches above the highest part of the crown sheet.

b. WATER GLASS VALVES (RULE No. 31). All water glasses will be supplied with two valves or shut-off cocks, one at the upper and one at the lower connection to the boiler, and also a drain cock; valves and cocks will be constructed so that they can be opened and closed easily by hand.

c. TIME OF CLEANING (RULE No. 32). The spindles of all gauge cocks and water glass cocks will be removed and cocks thoroughly cleaned of scale and sediment at least once each month.

d. TESTING AND MAINTENANCE (RULE No. 33). All water glasses will be blown out and gauge cocks tested before each trip; gauge cocks will be maintained in such condition that they can be opened and closed easily by hand without the aid of a wrench or other tool.

e. WATER AND LUBRICATOR GLASS SHIELDS (RULE No. 34). All tubular water glasses and lubricator glasses will be equipped with a safe and suitable shield which will prevent the glass from flying in case of breakage; such shield will be maintained properly.

f. WATER GLASS LAMPS (RULE No. 35). All water glasses will be supplied with a suitable lamp properly located to enable the engineer to see easily the water in the glass.

22. Injectors (Rule No. 36)

Injectors will be kept in good condition, free from scale, and will be tested before each trip. Boiler checks, delivery pipes, feed water pipes, tank hose and tank valves will be kept in good condition, free from leaks and from foreign substances that could obstruct the flow of water.

23. Washing Boilers

a. **TIME OF WASHING (RULE No. 37).** All boilers will be washed thoroughly as often as the water conditions require, but not less frequently than once each month. All boilers will be considered as having been in continuous service between washouts unless the dates of the days that the boiler was out of service are certified properly on washout reports and the report of inspection.

b. **PLUGS TO BE REMOVED (RULE No. 38).** When boilers are washed, all washout, arch, and water bar plugs will be removed.

c. **WATER TUBES (RULE No. 39).** Special attention will be given the arch and water bar tubes; see that they are free from scale and sediment.

d. **OFFICE RECORD (RULE No. 40).** An accurate record of all locomotive boiler washouts will be kept in the office of the unit on WD AGO Form 55-231 (ch. 12). The following information will be entered on the day that the boiler is washed:

- (1) Number of locomotive.
- (2) Date of washout.
- (3) Signature of boiler washer or inspector.
- (4) Statement that spindles of gauge cocks and waterglass cocks were removed and cocks cleaned.

(5) Signature of the boiler inspector or the person who removed the spindles and cleaned the cocks.

24. Steam Leaks

a. **LEAKS UNDER LAGGING (RULE No. 41).** If a serious leak develops under the lagging, an examination will be made and the leak located. If the leak is due to a crack in the shell or to any other defect which may reduce safety, the boiler will be taken out of service immediately, repaired, and reported to be in satisfactory condition before it is returned to service.

b. **LEAKS IN FRONT OF ENGINEMEN (RULE No. 42).** All steam valves, cocks, and joints, studs, bolts, and seams will be kept in such repair that they will not emit steam in front of enginemen so as to obscure clear vision.

25. Reports

a. **FILING (RULE No. 43).** Responsible personnel will complete and file all reports as required in chapter 12.

b. **ACCIDENT REPORTS (RULE No. 44).** If an accident results from the failure of a locomotive boiler or any of its parts, and causes serious injury or death to one or more persons, the unit operating the locomotive will transmit immediately a report of such accident to the railway grand division headquarters, if in a theater of operations, or to the chief of transportation, if in the zone of interior. This report will state the nature of the accident, the place at which it occurred, as well as where the locomotive may be inspected.

Section II. BRAKE EQUIPMENT

26. General (Rule No. 45)

Before each trip the brakes on locomotive and tender will be in safe and suitable condition for service; the air compressor or compressors in condition to provide an ample supply of air for the service in which the locomotive is placed; the devices for regulating all pressures performing their functions properly; the brake valves working properly in all positions; and the water drained from the airbrake system.

27. Compressors (Rule No. 46)

a. The compressor or compressors will be tested for capacity by orifice test as frequently as conditions may require, but not less frequently than once each 3 months.

b. The diameter of orifice, speed of compressor, and the air pressure to be maintained for compressors in common use are given in the following table: *(This table will be used for altitudes to and including 1,000 feet. For altitudes over 1,000 feet the speed of compressor may be increased 5 single strokes per minute for each 1,000 feet increase in altitude.)*

Make	Size compressor	Single strokes per minute	Diameter of orifice (in.)	Air pressure maintained (lb.)
Westinghouse	9½ in.	120	11/64	60
Westinghouse	11 in.	100	3/16	60
Westinghouse	8½ in. c.c.	100	9/32	60
New York	2a	120	5/32	60
New York	6a	100	13/64	60
New York	5b	100	15/64	60

28. Testing Main Reservoirs (Rule No. 47)

a. Every main reservoir before being put into service, and at least once each 12 months thereafter, will be subjected to hydrostatic pressure of not less than 25 percent above the maximum allowed air pressure.

b. The entire surface of the reservoir will be hammer-tested each time the locomotive is shopped for general repairs, but not less frequently than once each 24 months.

29. Air Gauges (Rule No. 48)

a. Air gauges will be located so that they may be read conveniently by the engineer from his customary position in the cab. Air gauges will be tested at least once each 3 months, and also when any irregularity is reported.

b. Air gauges will be compared with an accurate test gauge or dead-weight tester, and gauges found incorrect will be repaired before they are returned to service.

30. Time of Cleaning (Rule No. 49)

Distributing or control valves, reducing valves, triple valves, straight-air double-check valves, and dirt collectors will be cleaned as often as conditions require to maintain them in a safe and suitable condition for service, but not less frequently than once every 6 months.

31. Testing and Tagging (Rule No. 50)

The date of testing or cleaning, and the initials of the shop or station at which the work is done, will be stenciled legibly in a conspicuous place on the parts, or placed on a card displayed under glass in the cab of the locomotive, or stamped on metal tags. When metal tags are used, the height of letters and figures will be not less than $\frac{3}{8}$ inch, and the tags located as follows:

a. One attached securely to brake pipe near automatic brake valve, which will show the date on which the distributing valve, control valve or triple valves, reducing valves, straight-air double-check valves, dirt collectors, and brake cylinders were cleaned and cylinders lubricated.

b. One attached securely to air compressor steam pipe, which will show the date on which the compressor was tested by orifice test.

c. One attached securely to the return pipe near

main reservoir, which will show the date on which the hydrostatic test was applied to main reservoirs.

32. Piston Travel (Rule No. 51)

a. The minimum piston travel will be sufficient to provide proper brake shoe clearance when the brakes are released.

b. The maximum piston travel when locomotive is standing will be as follows:

	Inches
Cam type of driving wheel brake..	3½
Other forms of driving wheel brake	6
Engine truck brake.....	8
Tender brake.....	9

33. Foundation Brake Gear (Rule No. 52)

a. Foundation brake gear will be maintained in a safe and suitable condition for service. Levers, rods, brake beams, hangers, and pins will be of ample strength, and will not be fouled in any way which will affect the proper operation of the brake. All pins will be secured properly in place with cotters, split keys, or nuts. Brake shoes will be applied properly and will be kept approximately in line with the tread of the wheel.

b. In the zone of interior, no part of the foundation brake gear of the locomotive or tender will be less than 2½ inches above the rails, and in the theater of operations, not less than the minimum clearance prevailing in the area concerned. In no case, however, will the minimum clearance be less than 2½ inches.

34. Leakage (Rule No. 53)

a. Leakage from the main reservoir and related piping will not exceed an average of 3 pounds per minute in a test of 3 minutes' duration made after the pressure has been reduced 40 percent below the maximum pressure.

b. Brake pipe leakage will not exceed 5 pounds per minute at any time.

c. With a full service application from maximum brake pipe pressure and with communication to the brake cylinders closed, the brakes on the locomotive and tender will remain applied at least 5 minutes, otherwise a brake cylinder leakage is indicated.

35. Train Signal System (Rule No. 54)

The train signal system, when used, will be tested and known to be in safe and suitable condition for service before each trip.

Section III. CABS, WARNING SIGNALS, AND SANDERS

36. Cabs (Rule No. 55)

a. Cabs will be attached or braced securely and maintained in a safe and suitable condition for service. Cab windows will be located and maintained so that the enginemen may have a clear view of track and signals from their usual and proper positions in the cab.

b. Steam pipes will not be fastened to the cab. On new construction, or when renewals are made of iron or steel pipe subject to boiler pressure in cabs, extra strong pipe with extra heavy valves and fittings will be used.

37. Cab Aprons (Rule No. 56)

Cab aprons will be of proper length and width to insure safety. Aprons will be hinged securely, maintained in a safe and suitable condition for service,

and roughened, or other provision made, to afford secure footing.

38. Cylinder Cocks (Rule No. 57)

Necessary cylinder cocks, operative from cab of locomotive, will be provided and maintained in a safe and suitable condition for service.

39. Sanders (Rule No. 58)

Locomotives will be equipped with proper sanding apparatus; apparatus will be maintained in safe and suitable condition for service and tested before each trip. Sand pipes will be fastened securely in line with the rails.

40. Whistle (Rule No. 59)

Each locomotive will be provided with a suitable steam whistle, and arranged so that it may be operated conveniently by the engineer.

Section IV. DRAWGEAR, DRAFT GEAR, DRIVING GEAR, AND RUNNING GEAR

41. Drawgear and Draft Gear (Rule No. 60)

a. DRAWGEAR. (1) The drawgear between the locomotive and tender, together with the pins and fastenings, will be maintained in a safe and suitable condition for service. The pins and drawbar will be removed and examined carefully for defects not less frequently than once each 3 months. Suitable means for securing the drawbar pins in place will be provided. Inverted drawbar pins will be held in place by a plate or stirrup.

(2) Two or more safety bars or safety chains of ample strength will be provided between locomotive and tender, maintained in safe and suitable condition for service, and inspected at the same time the drawgear is inspected.

(3) Safety chains or safety bars will be of the minimum length consistent with the curvature of the railroad on which the locomotive is operated.

(4) Lost motion between locomotives and tenders not equipped with spring buffers will be kept to a minimum, and will not exceed $\frac{1}{2}$ inch.

(5) When spring buffers are used between locomotive and tender the spring will be applied with not less than $\frac{3}{4}$ -inch compression, and at all times will

be under sufficient compression to keep the chafing faces in contact.

b. CHAFING IRONS (RULE No. 61). Chafing irons, of such radius as will permit proper curving, will be attached securely to locomotive and tender and will be maintained in condition to permit free movement laterally and vertically.

c. DRAFT GEAR (RULE No. 62). Draft gear and attachments on locomotives and tenders will be fastened securely and maintained in safe and suitable condition for service.

42. Driving Gear

a. CROSSHEADS (RULE No. 63). Crossheads will be maintained in a safe and suitable condition for service with not more than $\frac{1}{4}$ -inch vertical or $\frac{5}{16}$ -inch lateral play between crossheads and guides.

b. GUIDES (RULE No. 64). Guides will be fastened securely and maintained in a safe and suitable condition for service.

c. PISTONS AND PISTON RODS (RULE No. 65). Pistons and piston rods will be maintained in safe and suitable condition for service. Piston rods will be examined carefully for cracks each time they are moved, and will be renewed if found defective. All

piston rods will have the date of application, original diameter, and kind of material stamped legibly on or near the end of rod.

d. RODS, MAIN AND SIDE (RULE No. 66). (1) Cracked or defective main or side rods will not be continued in service.

(2) Autogenous welding of broken or cracked main or side rods will not be permitted.

(3) Bearings and bushings will so fit the rods as to be in a safe and suitable condition for service; means will be provided to prevent the bushings from turning in the rod. Straps will fit and be bolted securely to rods.

(4) The total amount of side motion of rods on crank pins will not exceed $\frac{1}{4}$ inch.

(5) Oil and grease cups will be attached securely to rods, and grease-cup plugs will be equipped with suitable fastenings.

(6) For locomotives used in road service the bore of main rod bearings will not exceed pin diameters more than $\frac{3}{32}$ inch at front or back end; the total lost motion at both ends will not exceed $\frac{5}{32}$ inch.

(7) The bore of side rod bearing will not exceed pin diameters more than $\frac{5}{32}$ inch on main pin nor more than $\frac{3}{16}$ inch on other pins.

(8) For locomotives used in yard service the bore of main rod bearings will not exceed pin diameters more than $\frac{1}{8}$ inch at front end or $\frac{5}{32}$ inch at back end.

(9) The bore of side rod bearings will not exceed pin diameters more than $\frac{3}{16}$ inch.

43. Running Gear

a. DRIVING, TRAILING, AND ENGINE TRUCK AXLES (RULE No. 67). These axles, with any of the following defects, will not be continued in service: bent axle; cut journals that cannot be made to run cool without turning; seamy journals in steel axles; transverse seams in iron axles, or any seams in iron axles causing journals to run hot or become unsafe on account of usage, accident, or derailment; driving, trailing, or engine truck axles more than $\frac{1}{2}$ inch under original diameter, except for locomotives having all driving axles of the same diameter, when other than main driving axles may be worn $\frac{3}{4}$ inch below the original diameter.

b. TENDER TRUCK AXLES. (1) *Defects (Rule No. 68).* These axles, with any of the following defects, will not be continued in service: bent axle; cut journals that cannot be made to run cool without turning; seamy journals in steel axles, or transverse seams in journals of iron axles, or unsafe on account of usage, accident, or derailment; collars broken or

worn to $\frac{1}{4}$ inch or less in thickness; fillet in back shoulder worn out.

(2) *Minimum Diameters (Rule No. 69).* The minimum diameters of tender truck axles for various axle loads will be as follows:

Axle load (lb.)	Standard Axles (in.)	Minimum diameter of journal (in.)	Minimum diameter of wheel seat (in.)	Minimum diameter of center (in.)
50,000	6 x 11	5½	7¾	6⅞
38,000	5½ x 10	5	6¾	5⅞
31,000	5 x 9	4½	6¼	5⅝
22,000	4¼ x 8	3¾	5	4¾
15,000	3¾ x 7	3¼	4⅝	3¾

c. CRANK PINS (RULE No. 70). (1) Crank pins will be applied securely; shimming or prick-punching crank pins will not be done.

(2) Crank-pin collars and collar bolts will be maintained in a safe and suitable condition for service.

d. DRIVING BOXES (RULE No. 71). Driving boxes will be maintained in a safe and suitable condition for service. Broken and loose bearings will be renewed. Not more than one shim may be used between box and bearing.

e. DRIVING BOX SHOES AND WEDGES (RULE No. 72). Driving-box shoes and wedges will be maintained in a safe and suitable condition for service.

f. FRAMES (RULE No. 73). Frames, deck plates, tailpieces, pedestals, and braces will be maintained in a safe and suitable condition for service, and will be cleaned and inspected thoroughly each time the locomotive is in shop for heavy repairs.

g. LATERAL MOTION (RULE No. 74). (1) The total lateral motion or play between the hubs of the wheels and the boxes on any pair of wheels will not exceed the following limits:

	Inches
For engine truck wheels (trucks with swing centers)	1
For engine truck wheels (trucks with rigid centers)	1½
For trailing truck wheels	1
For driving wheels (more than one pair)	¾

(2) These limits may be increased on locomotives operating on track where the curvature exceeds 20° and when it can be shown that conditions require additional lateral motion.

(3) The lateral motion in all cases will be kept within such limits that the driving wheels, rods, or crank pins will not interfere with other parts of the locomotive.

h. PILOTS (RULE No. 75). (1) Pilots will be attached securely, braced properly, and maintained in a safe and suitable condition for service.

(2) The minimum clearance of pilot above the rail will be 3 inches, and the maximum clearance 6 inches.

i. SPRING RIGGING (RULE No. 76). (1) Springs and equalizers will be arranged to insure the proper distribution of weight to the various wheels of the locomotive and will be maintained approximately level and in a safe and suitable condition for service.

(2) Springs or spring rigging with any of the following defects will be renewed or repaired: top leaf broken, two leaves in top half broken, or any three leaves in spring broken (the long side of spring

will be considered the top); springs with leaves working in band; broken coil springs; and broken driving-box saddle, equalizers, hanger, bolt, or pin.

j. TRUCKS, LEADING AND TRAILING (RULE No. 77). (1) Trucks will be maintained in safe and suitable condition for service. Center plates will fit properly and the male center plate extend into the female center plate not less than $\frac{3}{4}$ inch. All centering devices will be maintained properly.

(2) A suitable safety chain will be provided at each front corner of all four wheel engine trucks.

(3) All parts of trucks will have sufficient clearance to prevent them from interfering seriously with any other part of the locomotive.

Section V. WHEELS

44. Wheels Tight on Axle (Rule No. 78)

a. Wheels will be pressed securely on axles. Prick-punching or shimming the wheel fit will not be done. The diameter of wheels on the same axle will not vary more than $\frac{3}{32}$ inch.

b. Wheels used on standard gauge track will be out of gauge if the inside gauge of flanges, measured on base line, is less than 53 inches or more than $53\frac{3}{8}$ inches.

c. The distance back-to-back of flanges of wheels mounted on the same axle will not vary more than $\frac{1}{4}$ inch.

45. Cast-Iron or Cast-steel Wheels (Rule No. 79)

Such wheels with any of the following defects will not be continued in service:

a. SLID FLAT. When the flat spot is $2\frac{1}{2}$ inches or over in length, or if there are two or more adjoining spots each 2 inches or over in length.

b. BROKEN OR CHIPPED FLANGE. If the chip exceeds $1\frac{1}{2}$ inches in length and $\frac{1}{2}$ inch in width.

c. BROKEN RIM. If the tread, measured from the flange at a point $\frac{5}{8}$ inch above the tread, is less than $3\frac{3}{4}$ inches in width.

d. SHELLED OUT. Wheels with defective treads on account of cracks or shelled out spots $2\frac{1}{2}$ inches or over, or so numerous as to endanger the safety of the wheel.

e. BRAKE BURN. Wheels having defective tread on account of cracks or shelling out due to heating.

f. Seams $\frac{1}{2}$ inch long or over, at a distance of $\frac{1}{2}$ inch or less from the throat of the flange, or seams 3 inches or more in length, if such seams are within

the limits of $3\frac{3}{4}$ inches from the flange, measured at a point $\frac{5}{8}$ inch from the tread.

g. WORN FLANGES. Wheels on axles with journals 5 inches by 9 inches or over with flanges having flat vertical surfaces extending $\frac{7}{8}$ inch or more from the tread, or flanges 1 inch thick or less gauged at a point $\frac{3}{8}$ inch above tread. Wheels on axles with journals less than 5 inches by 9 inches with flanges having flat vertical surfaces extending 1 inch or more from the tread, or flanges $\frac{1}{16}$ inch thick or less, gauged at a point $\frac{3}{8}$ inch above the tread.

h. TREAD WORN HOLLOW. If the tread is worn sufficiently hollow to render the flange or rim liable to breakage.

i. BURST. If the wheel is cracked from the wheel fit outward.

j. Cracked tread, cracked plate, or one or more cracked brackets.

k. Wheels out of gauge.

l. Wheels loose on axle.

Note. The determination of flat spots, worn flanges, and broken rims will be made by a gauge as shown in figure 8, and its application to defective wheels as shown in figures 9, 10, 11, 12 and 13.

46. Forged Steel or Steel Tired Wheels (Rule No. 80)

Such wheels with any of the following defects will not be continued in service:

a. Loose wheels; loose, broken, or defective retaining rings or tires; broken or cracked hubs, plates, spokes, or bolts.

b. Slid flat spot $2\frac{1}{2}$ inches or longer, or, if there are two or more adjoining spots, each 2 inches or longer.

c. Defective tread on account of cracks or shelled out spots 2½ inches or longer, or so numerous as to endanger the safety of the wheel.

d. Broken flange.

e. Flange worn to 15/16 inch or less in thickness, gauged at a point 3/8 inch above the tread, or having flat vertical surface, 1 inch or more from tread; tread worn 15/16 inch; flange more than 1½ inches from tread to top of flange, or thickness of tires or rims less than shown in figures 4, 5, 6 and 7.

f. Wheels out of gauge.

47. Driving and Trailing Wheels (Rule No. 81)

a. GENERAL. Driving and trailing wheel centers with divided rims will be fitted properly with iron or steel filling blocks before the tires are applied, and such filling blocks will be maintained properly. When shims are inserted between the tire and the wheel center, not more than two thicknesses of shims will be used, one of which will extend entirely around the wheel.

b. DRIVING WHEEL COUNTERBALANCE (RULE No. 82). This will be maintained in a safe and suitable condition for service.

c. DRIVING AND TRAILING WHEEL DEFECTS (RULE No. 83). Such whels with any of the following defects will not be continued in service:

(1) Driving or trailing wheel centers with three adjacent spokes or 25 percent of the spokes in wheel broken.

(2) Loose wheels; loose, broken, or defective tires or tire fastenings; broken or cracked hubs, or wheels out of gauge.

d. DRIVING AND TRAILING WHEEL TIRES (RULE No. 84). (1) The minimum height of flange for driving or trailing wheel tires, measured from tread, will be 1 inch for locomotives used in road service, except that on locomotives where construction will not permit the full height of flange on all drivers, the minimum height of flange on one pair of driving wheels may be 5/8 inch.

(2) The minimum height of flange for driving wheel tires, measured from tread, will be 7/8 inch for locomotives used in switching service.

(3) The maximum taper for tread of tires from throat of flange to outside of tire, for driving and trailing wheels for locomotives used in road service, will be 1/4 inch, and for locomotives used in switching service, 5/16 inch.

(4) The minimum width of tires for driving and trailing wheels of standard-gauge locomotives will be 5½ inches for flanged tires, and 6 inches for plain tires.

(5) The minimum width of tires for driving and trailing wheels of narrow gauge locomotives will be 5 inches for flanged tires, and 5½ inches for plain tires.

(6) When all tires are turned or new tires applied to driving and trailing wheels, the diameter of the wheels on the same axle, or in the same driving wheel base, will not vary more than 3/32 inch. When a single tire is applied the diameter will not vary more than 3/32 inch from that of the opposite wheel on the same axle. When a single pair of tires is applied the diameter will be within 3/32 inch of the average diameter of the wheels in the driving wheel base to which they are applied.

(7) Driving and trailing wheel tires with any of the following defects will not be continued in service: Slid flat spot 2½ inches or more in length; flange 15/16 inch or less in thickness, gauged at a point 3/8 inch above the tread; or having flat vertical surface 1 inch or more from tread; tread worn hollow 5/16 inch on locomotives used in road service, or 3/8 inch on locomotives used in switching service; flange more than 1½ inches from tread to top of flange. (See figs. 1, 2 and 3.)

Note. The determination of flat spots and worn flanges will be made by a gauge as shown in figure 8, and its application to defective tires as shown in figures 9, 10, 11 and 12.

48. Minimum Tire Thickness (Rule No. 85)

a. Minimum thickness for driving wheel tires on standard and narrow gauge locomotives are:

Weight per axle (weight on drivers divided by number of pairs of driving wheels) (lb.)	Diameter of wheel center (in.)	Minimum thickness service limits	
		Road service	Switching service
30,000 and under	44 and under	1¼	1⅜
	Over 44 to 50	15/16	13/16
	Over 50 to 56	13/8	1¼
	Over 56 to 62	17/16	15/16
	Over 62 to 68	1½	.....
	Over 68 to 74	19/16	.....
	Over 74	15/8	.....
Over 30,000 to 35,000	44 and under	15/16	13/16
	Over 44 to 50	13/8	1¼
	Over 50 to 56	17/16	15/16
	Over 56 to 62	1½	13/8
	Over 62 to 68	19/16	.....
	Over 68 to 74	15/8	.....
	Over 74	111/16	.....
Over 35,000 to 40,000	44 and under	13/8	1¼
	Over 44 to 50	17/16	15/16
	Over 50 to 56	1½	13/8
	Over 56 to 62	19/16	17/16
	Over 62 to 68	15/8	.....
	Over 68 to 74	111/16	.....
	Over 74	13/4	.....

Weight per axle (weight on drivers divided by number of pairs of driving wheels) (lb.)	Diameter of wheel center (in.)	Minimum thickness service limits	
		Road service	Switching service
Over 40,000 to 45,000	44 and under	$1\frac{7}{16}$	$1\frac{5}{16}$
	Over 44 to 50	$1\frac{1}{2}$	$1\frac{3}{8}$
	Over 50 to 56	$1\frac{9}{16}$	$1\frac{7}{16}$
	Over 56 to 62	$1\frac{5}{8}$	$1\frac{1}{2}$
	Over 62 to 68	$1\frac{11}{16}$	.....
	Over 68 to 74	$1\frac{3}{4}$	.....
	Over 74	$1\frac{13}{16}$	.....
	Over 45,000 to 50,000	44 and under	$1\frac{1}{2}$	$1\frac{3}{8}$
Over 44 to 50		$1\frac{9}{16}$	$1\frac{7}{16}$
Over 50 to 56		$1\frac{5}{8}$	$1\frac{1}{2}$
Over 56 to 62		$1\frac{11}{16}$	$1\frac{9}{16}$
Over 62 to 68		$1\frac{3}{4}$	.....
Over 68 to 74		$1\frac{13}{16}$	.....
Over 74		$1\frac{7}{8}$	.....
Over 50,000 to 55,000		44 and under	$1\frac{9}{16}$	$1\frac{7}{16}$
	Over 44 to 50	$1\frac{5}{8}$	$1\frac{1}{2}$
	Over 50 to 56	$1\frac{11}{16}$	$1\frac{9}{16}$
	Over 56 to 62	$1\frac{3}{4}$	$1\frac{5}{8}$
	Over 62 to 68	$1\frac{13}{16}$	.....
	Over 68 to 74	$1\frac{7}{8}$	.....
	Over 74	$1\frac{15}{16}$	.....

Weight per axle (weight on drivers divided by number of pairs of driving wheels) (lb.)	Diameter of wheel center (in.)	Minimum thickness service limits	
		Road service	Switching service
Over 55,000	44 and under	$1\frac{5}{8}$	$1\frac{1}{2}$
	Over 44 to 50	$1\frac{11}{16}$	$1\frac{9}{16}$
	Over 50 to 56	$1\frac{3}{4}$	$1\frac{5}{8}$
	Over 56 to 62	$1\frac{13}{16}$	$1\frac{11}{16}$
	Over 62 to 68	$1\frac{7}{8}$	.....
	Over 68 to 74	$1\frac{15}{16}$	.....
	Over 74	2	.....

b. When retaining rings are used, measurements of tires will be taken from the outside circumference of the ring, and the minimum thickness of tires may be as much below the limits specified above as the tires extend between the retaining rings, provided it does not reduce the thickness of the tire to less than $1\frac{1}{8}$ inches from the throat of flange to the counter-bore for the retaining ring.

c. The minimum thickness for driving wheel tires will be 1 inch for locomotives operated on track of 2-foot gauge,

Section VI. LIGHTS

49. Maintenance (Rule No. 86)

Electrical equipment for lighting on locomotives so equipped will be maintained in safe and serviceable condition.

50. Locomotives Used in Road Service (Rule No. 87)

a. Each locomotive used in road service between sunset and sunrise will have a headlight affording sufficient illumination for locomotive engineers in a clear atmosphere to see a dark object as large as a man standing erect at a distance of at least 800 feet in front of the locomotive.

b. Each locomotive which regularly is required to run backward for any portion of its trip, except to pick up a detached portion of its train, or in making terminal movements, will have a rear headlight which will meet the requirements of *a* above.

c. Such headlights will be provided with a device whereby the light from them may be diminished at stations and in yards or when meeting trains.

d. When two or more locomotives are used in the

same train only the leading locomotive will be required to display a headlight.

51. Locomotives Used in Yard Service (Rule No. 88)

Each locomotive used in yard service between sunset and sunrise, will have two lights, one located on the front of the locomotive and one on the rear. Each of these lights will be sufficient to enable a person in the cab of a locomotive under the conditions set forth in rule No. 87, to see a dark object such as that described, for a distance of at least 300 feet in front of the headlight.

52. Cab Lights (Rule No. 89)

Each locomotive used between sunset and sunrise will have cab lights which will provide sufficient illumination upon the steam, air, and water gauges to enable the engineers to make necessary and accurate readings from their usual and proper positions in the cab. These lights will be located and constructed so that the light will shine only on those parts requiring illumination.

Section VII. THROTTLE AND REVERSING GEAR; ASH PANS

53. Throttles (Rule No. 90)

Throttles will be maintained in safe and suitable condition for service, and efficient means provided to hold the throttle lever in any desired position.

54. Reverse Gear (Rule No. 91)

Reverse gear, reverse levers, and quadrants will be maintained in safe and suitable condition for service. Reverse lever latch will be arranged so that it can be disengaged easily and provided with a spring which will keep it firmly seated in quadrant. Proper

counterbalance will be provided for the valve gear.

55. Ash Pans (Rule No. 92)

a. The operating mechanism of all ash pans will be maintained in a safe and suitable condition for service.

b. In the zone of interior no part of the ash pan will be less than $2\frac{1}{2}$ inches above the rail, and in theaters of operation not less than the minimum clearance prevailing in the area concerned. In no case, however, will the minimum clearance be less than $2\frac{1}{2}$ inches.

Section VIII. TENDERS

56. Tender Frames (Rule No. 93)

a. Tender frames will be maintained in a safe and suitable condition for service.

b. The difference in height between the deck on the tender and the cab floor or deck on the locomotive will not exceed $1\frac{1}{2}$ inches.

c. The minimum width of the gangway between locomotive and tender, while standing on straight track, will be 16 inches.

57. Feed Water Tanks (Rule No. 94)

a. Tanks will be maintained free from leaks, and in safe and suitable condition for service. Suitable screens will be provided for tank wells or tank hose.

b. Not less frequently than once each month the interior of the tank will be inspected, and cleaned if necessary.

c. Top of tender behind fuel space will be kept clean, and means provided to carry off waste water. Suitable covers will be provided for filling holes.

58. Oil Tanks (Rule No. 95)

The oil tanks on oil-burning locomotives will be maintained free from leaks. An automatic safety

cut out valve, which may be operated by hand from inside and outside of cab, will be provided for the oil-supply pipe.

59. Tender Trucks (Rule No. 96)

a. Tender truck center plates will be fastened securely, maintained in a safe and suitable condition for service, and provided with a center pin properly secured. When shims are used between truck center plates, the male center plate will extend into the female center plate not less than $\frac{3}{4}$ inch.

b. Truck bolsters will be maintained approximately level.

c. When tender trucks are equipped with safety chains, they will be maintained in a safe and suitable condition for service.

d. Side bearings will be maintained in safe and suitable condition for service.

e. Friction side bearings will not be run in contact.

f. The maximum clearance of side bearings on rear truck will be $\frac{3}{8}$ inch, and if used on front truck $\frac{3}{4}$ inch, when the spread of side bearings is 50 inches. When the spread of the side bearings is increased, the maximum clearance may be increased in proportion.

Section IX. REPORTS

60. Filing Reports (Rule No. 97)

Responsible personnel will complete and file reports as required in chapter 12.

61. Accident Reports (Rule No. 98)

If an accident results from the failure, from any cause, of a locomotive or tender, or any of its parts, and causes serious injury or death to one or more

persons, the unit which operates such locomotive will transmit immediately a report of such accident to the railway grand division headquarters in theaters of operations or to the chief of transportation in the zone of interior. This report will give specific information as to the nature of the accident, the place where the accident occurred, and the location where the locomotive may be inspected.

INSPECTION AND MAINTENANCE OF STEAM LOCOMOTIVES

Section I. BASIC PRINCIPLES

62. General

a. Careful daily inspection followed immediately by corrective measures will keep railroad equipment in operation for long periods of time and will reduce the cost of running repairs as well as the cost of major overhauls. Preventive maintenance on each piece of equipment will be made an indispensable part of the operation and its necessity impressed on the operating personnel.

b. A suitable inspection pit will be provided to enable operating or maintenance personnel to inspect, to pack journals, and to make necessary repairs and adjustments to parts underneath locomotives and locomotive cranes.

c. The condition of exterior surfaces of smoke-boxes, boilers, fireboxes, frames, running gear, cabs, tenders, and locomotive cranes often indicate neglect of surface maintenance. Those responsible for War Department rail equipment will insure the protection of all metal surfaces. (See ch. 11.)

63. Responsibilities

a. The engineer is responsible for the equipment he is operating. His primary duty is to operate the equipment assigned to him efficiently and economically. His secondary duty is to maintain his locomotive in a clean, mechanically sound, and properly lubricated condition. He will inspect and make repairs daily to his locomotive, paying particular attention to proper lubrication. Daily work reports will be made on standard forms for the officer in charge of the equipment and these reports will be kept on file where the locomotive is assigned.

b. The fireman's primary responsibility is maintenance of the water level and proper steam pressure. He is subordinate to the engineer and will carry out his duties in conformance with the instructions of the engineer. The fireman will conserve fuel and report poor fuel to the officer in charge. He will ob-

serve proper procedures for firing and practice economy in the use of fuels and supplies. He will keep the deck and gangway clean for safety and convenience.

c. Both fireman and engineer will avoid the following abuses:

(1) Carelessly or improperly supplying water to the boiler.

(2) Improper firing or allowing the boiler to expand and contract unnecessarily by varying the steam pressure.

(3) Using the injector incorrectly by filling the boiler at a rapid rate when drifting or standing, unless there is a bright fire to heat the injector water to the boiler temperatures as fast as it comes into the boiler.

(4) Using the blower excessively, especially with a light fire or when cleaning a fire.

(5) Carrying too much or too little water in the boiler.

(6) Failing to open cylinder cocks to relieve the cylinders of condensation when starting or when water rises in the boiler.

(7) Using injectors or feedwater pumps while boiler is being blown down, or less than 4 minutes prior to blowing down.

(8) Neglecting the machinery by not keeping parts properly lubricated, adjusted and repaired.

(9) Working water through cylinders.

(10) Allowing engine to slip unnecessarily or pound excessively.

d. Burning a steam locomotive boiler through neglect of the crew is a serious offense and calls for disciplinary action. Boilers are burned as a result of—

(1) Allowing boiler water level to become lower than the top of the crown sheet.

(2) Allowing the boiler interior to become so badly scaled or mud-packed that heat transfer is not accomplished through the sheets to the water.

e. If cylinders, air pumps, feed water system, lubricators, and steam pipes are improperly drained, they may freeze. Damage by freezing caused by carelessness will result in disciplinary action.

f. All steam leaks from packing nuts and glands will be corrected as soon as they develop. If leaks

develop which cannot be stopped by the locomotive crew, the defects causing them will be reported immediately to the officer in charge so that corrective measures may be taken. Uncorrected and unreported leaks indicate a careless and incompetent engineman.

Section II. FIRING LOCOMOTIVES

64. General Procedures

a. Before a locomotive is fired, the enginehouse foreman and engine watchman or fire lighter personally will:

(1) Spot the locomotive correctly in the roundhouse so that the stack is directly under the roundhouse smoke-jack to prevent the roof from being ignited.

(2) Determine that there is ample water in the boiler; at least two gauges of water or one-half glass. Keep both top and bottom water glass cocks wide open; check the water level by opening the drain valve under water glass and make sure that the water returns to the proper level when the drain valve is closed; and check the water level in the glass by opening the gauge cocks.

(3) See that the blow-off cocks are not leaking at the blow-down muffler.

(4) See that the cylinder cocks are open.

(5) See that the steam-chest relief valves are open.

(6) See that the engine is blocked with a chain ahead and behind each main wheel.

(7) See that the throttle is closed tightly and that the reverse lever is in center position.

(8) Examine the firebox for any foreign matter; determine the condition of brick work; note if the flues are free from leaks, and if the dampers are in operating condition.

(*a*) On oil-burning locomotives note the condition of the burner and remove carbon, firebrick, or other obstructions which would interfere with the flame from the burner to the opposite end of the firebox.

(*b*) On coal-burning locomotives, inspect the grates, grate bars and center grates.

(9) Make certain that the record is signed by both enginehouse foreman and engine watchman or firelighter, showing the time and date when the engine was ready to be fired up and the time it was actually fired up by engine watchman or firelighter.

b. Personnel responsible for proper firing of War

Department steam locomotives will secure greater safety and efficiency in the use of this equipment by observing the following instructions:

(1) The engine crew, when going on duty, will first ascertain the water level in the boiler by testing gauge cocks and water glass; tests will be made also at frequent intervals between terminals. Carelessness may cause severe damage to the boiler and possible explosion; never let the water get below the bottom of the water gauge glass or the bottom gauge cock.

(*a*) To test water-gauge glass, alternately open and close the top and bottom water-gauge glass cocks with the water-gauge glass drain cock open, allowing each to blow about 30 seconds. Then open both water-gauge glass cocks and close the drain valve after which water should return to the glass immediately.

(*b*) To test water column, open drain cock and let water and steam blow about 30 seconds. Close drain valve and water should return immediately.

(*c*) Under no circumstances will water be added to the boiler when the water level cannot be determined definitely by test. In such instance, dump or kill the fire at once, cover the smokestack, and close the fire doors. Isolating the firebox from an influx of air in this manner will retard cooling of the firebox sheets and will materially reduce damage.

(2) In firing a locomotive, fire as light as possible for the work required; maintain an even steam pressure at all times; and carry a level fire on the grates, a little heavier at the sides and rear to prevent air from coming through too rapidly near the side and back sheets.

(3) The furnace door will not be opened unnecessarily. When the furnace door is opened, the flow of air through the flues increases in proportion to the amount of air that passes through the door and the rapid contraction of the flues and sheets of the firebox due to cold air makes leaks possible. The fire door will be securely latched as soon as the fire is started in the firebox and at all times when the locomotive is under fire.

(4) The feedwater heater will not be used by the engine watchman or the firelighters for placing water in the boiler. The injector only will be used for this purpose. Water must not be placed in the boiler when the fire has died down, as this will cause the flues to leak.

(5) In case the water in the boiler reaches the level of the bottom gauge cock, the fire must be extinguished immediately and the enginehouse foreman notified promptly. No water will be placed in the boiler unless so authorized by the foreman.

(6) Use blow-off cocks in accordance with instructions.

(7) Cab curtains will be rolled up or pulled aside when the engine is being fired up or is left unattended. This avoids any danger of a back flash which may ignite the curtains and the cab.

(8) When the fire is being cleaned or killed, excessive use of the blower damages the boiler by drawing cold air through the firebox and flues.

(9) Firelighters and engine watchmen will maintain careful watch over each engine in their charge by checking frequently the engines being fired up.

(10) Operating crews will make proper inspection of firebox sheets before leaving and after arriving at terminals, noting any defects on their report for attention of the proper authorities.

c. Personnel responsible for firing up oil burning locomotives will:

(1) Connect roundhouse blower to locomotive after blowing out condensation in the line, when not under steam.

(2) Drain water from the oil tank and open the drain on the engine oil heater.

(3) Use wood in starting the fire when steam pressure is not available to work the atomizer and blower; take care when putting the wood in the firebox to avoid damaging the brick work or burner.

(4) Insure flow of oil to burner by mild circulation of steam through engine oil heater and by heating oil in tank to provide an oil temperature of 150° to 165° F. at the burner. In cold or freezing weather, use blowback valve to clean out oil feed pipe into oil tank.

(5) Open atomizer valve to blow out any condensation that may be in the steam pipe or steam passage of burner.

(6) Open the damper.

(7) Open the blower valve slightly to create a light draft through the firebox in order to carry out any accumulation of gas that may originate in firebox.

(8) Open oil tank valve.

(9) Apply the wire basket carrying ignited waste in the firebox and stand to left side of fire door.

(10) Open the atomizer valve enough so that when the oil begins to flow, the steam current will be sufficient to carry the oil to the fire. Open firing valve carefully to avoid a heavy explosion when the oil ignites. Adjust firing valve and atomizer to generate steam without creating a black smoke.

(11) Never light a fire from heated bricks as an explosion may occur, resulting in personal injury and damage to the brick work. Adjust the atomizer and the firing valve so that the oil will be atomized and consumed as it passes from the burner. Avoid any careless adjustment that might cause wastage of oil and possible damage by fire or explosion if drippings from the burner drop into the pit and ignite. Make all observation through fire-door peep-hole, taking care to guard against the out-flash of flame which may follow the ignition of oil.

(12) When starting a fire in a locomotive having steam in its boiler from a previous fire that has been extinguished from any cause, take precautions against possible explosion by opening the blower sufficiently to draw the gases from the firebox and the flues.

(13) When the boilers are filled with cold water adjust the firing valve to require approximately 1½ hours to raise the steam pressure the first 50 pounds, and an additional hour to raise the pressure to 200 pounds. (A proportionately longer time will be taken when the maximum pressure is higher than 200 pounds.) When the boilers are filled with hot water, reduce the time consumed in firing up engines to an extent that will not injure the firebox or boiler.

(14) After the engine has 40 to 80 pounds of steam, depending upon the size of the engine, disconnect the roundhouse blower line and fire up the engine under its own steam.

(15) If wood has been used in starting the fire, burn or remove completely all wood from the firebox before moving the locomotive to avoid the danger of setting fire to adjacent buildings or inflammable material. Watch fire carefully as sparks from burning wood will be drawn through the flues and stack when the locomotive is working.

d. Personnel responsible for putting out fire in oil burning locomotive will:

(1) Shut off oil valve under tender.

(2) When oil in pipes between oil valve on tender and the burner has been allowed to flow out and burn, close the firing valve.

(3) Close the atomizer.

(4) Close the damper.

(5) Shut off blower.

(6) Close valves to tender open heater and to coil heater.

(7) See that the following valves are closed at the main fountain-blower, air pump, feedwater pump, dynamo and lubricator.

e. Personnel responsible for firing up coal burning locomotives, either hand fired or equipped with any type of stoker, will—

(1) Connect roundhouse blower to locomotive after blowing out condensation in the line.

(2) Inspect grates to see that they are level and that ash-pan doors are closed.

(3) Build thin coal bed on grates by use of scoop shovel.

(4) Throw lighted waste on top of coal bed and spray with wiping oil until coal bed is ignited.

(5) After engine has 60 pounds of steam, disconnect roundhouse blower line and operate blower with steam from boiler.

(6) On locomotives equipped with mechanical stokers, do not operate the stoker mechanism but use scoop shovel.

(7) Putting too many scoops of coal on a bright fire is a waste of fuel and reduces the effective grate area and the temperature of the firebox. The fire will be kept burning brightly and at as high and even a temperature as possible in order to consume the gases; this is accomplished by firing lightly and often. Improper or uneven firing has a tendency to cause the flues to leak. If the pressure is not maintained regularly the sudden change of temperature makes the flues and sheets of the firebox contract and expand. If an uneven fire is carried, holes will develop and cold air come through, lowering the temperature, chilling the flues and causing leaks. Carrying too heavy a fire causes clinkers to form.

(8) Starting a heavy train with a too light fire on the grates will lift the fire from the grates forming holes that admit cold air into the firebox which in turn reduce the boiler pressure and may start the flues to leaking. The rake will be used to level the fire whenever necessary.

(9) Allowing the ash pan to become filled with clinkers and ashes prevents the right amount of air

from reaching the firebox and may warp the ash pan and burn out the grates.

f. Personnel responsible for putting out fires and cleaning ash pans in coal-burning locomotives will:

(1) Shut off stoker engine and jet.

(2) Open ash pan hopper doors.

(3) Open blower slightly.

(4) Shake ash and any live fire into ash pan.

(5) Clean all ash and live fire from ash pan into cinder pit by means of blower nozzles, hooks, rakes, and the like.

(6) Quench the hot ash and live fire.

(7) Close hopper doors, lock grate shakers and shut off blower.

65. Safety Precautions

a. The netting in the smoke box or on top of smoke stack will be maintained in proper condition. The cinder slide and hand-hold plates will be in their proper places and securely fastened. It is important that the ash pan and ash-pan slide be properly secured and free from holes; otherwise, live coals will roll out of the pan and start fires along the track. To prevent throwing cinders in the vicinity of warehouses or places where fires may be started, unnecessary hard usage of the locomotive will be avoided.

b. Gauge cocks will be tested to see that they open and close; the water glass cock will be blown out to see that water circulates properly in the glass. Gauge cocks, water glass cocks, and water column connections will be cleaned out at time of monthly inspection and boiler wash-out.

c. Keep the cylinders free from water to avoid damaging the valves and cylinders, to insure perfect lubrication, and to obtain the most efficient service from the locomotive.

d. The driving wheels will not be slipped to get water out of the cylinders and steam passages; the water will be worked out by opening the cylinder cocks and starting the engine slowly.

e. Shaking of grates or cleaning the ash pan will not be done while the engine is in yards or passing over crossings and bridges. Fires started on the track by cleaning the ash pan will be extinguished promptly. Fires will not be cleaned or ash pans dumped over turn-outs or cross-overs.

Section III. FEEDWATER CONTROL AND BOILER MAINTENANCE

66. Feedwater Control

a. To insure that the water glass and its connections are in working order at all times, the water level will be proved by the use of the gauge cocks.

b. The boiler will be filled before the fire is drawn. Cold water will not be put into a boiler after the fire has been drawn since the flues have a tendency to contract and leak.

c. Water will not be supplied to the boiler any

faster than necessary to care for the existing conditions.

d. Foaming is caused by foreign matter such as oil, soap, alkali, soda, or grease getting into the boiler; all untreated feedwater contains foaming matter. *Priming* is caused by filling the boiler too full of water. In either of these conditions considerable damage is likely to result; there is danger of knocking out the cylinder heads or causing excessive strain on others parts of the equipment. This can be avoided by carrying the proper amount of water in the boiler, by obeying carefully the instructions pertaining to blowing down the boiler, and by operating the locomotive in the proper manner. In case of foaming or priming, the main throttle will be partly or entirely closed allowing boiler water to settle to its true level; cylinder cocks will be opened and the main throttle operated lightly to work the water out through the cylinder cocks.

e. When reaching the top of grades, have sufficient water in boiler to protect crown sheet before starting down grade, since the water level will drop when throttle opening is reduced or closed.

f. If the water disappears from the water-gauge glass immediately after closing the throttle, the throttle will be opened, the air brake used to keep the engine under control, and both injectors used to bring the water to the proper height again.

g. Injectors will be tested every day and worked regularly to keep them in good working order. Lack of attention to the second injector and failure to use it each day will allow the joints to work loose and the boiler check to fill up with mud and scale.

h. At least once each 30 calendar days boilers will be washed with water at sufficient pressure to dislodge all foreign matter. All wash-out plugs will be removed each time the boiler is washed out. Never use cold water to wash a hot boiler as the sudden contraction of the firebox may cause firebox sheets to crack or staybolts to break.

i. There is no locality in the continental United States or in the theaters of operations where feedwater does not require some treatment or processing to make it suitable for boiler use. For this reason, it is essential that boiler feedwater be properly treated by the use of boiler compounds. All personnel responsible for the care of locomotive boilers will follow the procedure outlined in Chapter 3. It is imperative that any treatment be administered in exact conformity to the instructions set down. All personnel are warned that improper or inadequate water treatment can lead to serious boiler conditions which are both detrimental and dangerous.

j. Adequate boiler blow-down is an essential ad-

junct to proper water treatment as well as to proper operation. Personnel responsible for this phase of operation will observe the following general instructions:

(1) Boilers will be blown down through the blow-down cock about $\frac{3}{4}$ of a glass (column) at least once each 8 hours and more frequently if conditions require. This reduces the concentration of foaming ingredients (called total dissolved solids) in the boiler water. A further advantage is gained by the prompt and frequent removal of sludge which collects at the mudring.

(2) All road locomotives which are equipped with blow-off cocks operated from the cab will be blown approximately every 20 miles for a period of 30 seconds. If the engine is equipped with cab-operated cocks on both right and left sides, the enginemen and firemen will alternate in performing blow-downs.

(3) It is preferable to have the pump or the injector shut off while blowing.

(4) Proper precautions will be observed when using blow-off cocks to prevent damage to property or injury to persons.

(5) The schedule given above is the minimum required. If foaming occurs, the engine will be blown down immediately and as frequently thereafter as necessary to obtain the proper water condition.

(6) Engines in switching service will be blown down approximately once each hour at any convenient location. It will be permissible to use blow-off cocks operated from the running board, provided the locomotive is not in motion when such blowing is performed.

67. Boiler Maintenance

a. Obstructed flues reduce the heating surface and the steaming capacity of the boiler. As a rule, they cause leaky flues and poor steaming conditions. The stoppage of a large number of flues decreases the heating surface and draft. Flues will be cleaned at time of each monthly washout and whenever conditions may require it.

b. Blowing of flues is accomplished by directing through each flue a jet of steam or compressed air from a suitable nozzle to insure complete removal of soot and cinders. In the event steam or air is not available, a suitable flue brush or rod may be used.

c. A boiler, to be in good condition and to operate efficiently, must have good circulation and be free from mud and scale. Proper water treatment and blowing of the boiler on schedule will produce these results.

d. If the leg of the firebox becomes filled with mud, no water will be in contact with the firebox

sheets and they will become blistered or mud-burned.

Section IV. MACHINERY MAINTENANCE, LUBRICATION, AND INSPECTION

68. Machinery Maintenance

a. GENERAL. Immediate correction of any unusual condition when first observed is necessary to avoid damage to the equipment and unnecessary major repairs.

b. WEDGES. When setting up the wedges, place driving wheel on the top quarter on the side with the loose wedge. The brake will not be set as the brake shoe will push the driving box against the wedge to be adjusted. The driving wheels will be blocked so the locomotive cannot move. The boxes will be pushed, with a little steam, against the shoe or dead wedge, and the wedge set up until it is a snug fit; it should be pulled down sufficiently to allow for expansion and then fastened. If wedges are set up too tight, the boxes will stick and the locomotive will ride hard. Inspection of the locomotive when moving will locate the defective wedge; usually the driving box gets hot. The wedges then should be pulled down immediately. The jam nuts on the wedge bolts should be loosened and backed down. If the wedge is stuck too tightly, it may be necessary to run one or more of the wheels over a block, or loosen the pedestal brace bolt and allow the jaws to spread.

c. ROD BRASSES. If properly fitted, rod brasses will be keyed brass to brass; if not so fitted, they will be keyed on the large part of the pin so that they will be sufficiently free to run without heating and snug enough to run without pounding. They will not be keyed tightly enough to prevent lateral movement of the brass on the pin.

d. SIDE RODS. The side rods on a Mogul or Consolidation type locomotive will be keyed by placing the engine on center on the side to be keyed. The brass on the main pin will be keyed up first, working each way toward the ends of the rods, with care taken to keep them the proper length so that they do not bind when passing either center. *The wedges will be set up properly before the side rods are keyed.*

69. Locomotive Lubrication

a. The object of lubrication is to keep a film of oil, grease, or some lubricant between two bearing surfaces to prevent excessive friction created when they are in close contact.

b. To give perfect lubrication the feeders of all oil cups will be adjusted to feed regularly as small a quantity of oil as possible, consistent with adequate lubrication.

c. When the engine is being oiled it is bad practice to disturb the packing on top of driving and engine truck boxes with the spout of an oil can. This packing is put on top of the boxes to assist in keeping dirt and dust out of oilholes and to aid in gradual lubrication from the top of the box. Disturbing the packing will permit grit and dirt to work into oil holes and bearings.

d. To insure perfect lubrication, enginemen will make sure that—

(1) Waste on top of all driving boxes and engine trucks is well oiled and in proper shape.

(2) All oil holes are open, except as stated in *c* above.

(3) The packing in cellars is in good condition and in contact with the journals.

(4) All grease cups are filled.

(5) The lubricator is working properly.

e. It is bad practice to keep engine oil close to the boiler in warm weather. The oil is thinned to such a degree by the heat of the boiler that it runs off as soon as it is applied and proper lubrication is not accomplished.

f. Engine oil (U. S. Army Specification No. 2-60D) will not be used in the lubricator because engine oil begins to separate and give off gas at 345° F.; thus it loses its lubricating qualities before it reaches the temperature of the valves and cylinders when they are working under steam. The temperature of steam at 120 pounds is 350° F. Valve oil (Federal Specification No. VV-O-601) will be used in lubricators.

g. Hot bearings will be cooled gradually to prevent undue strain on the metal. Defective lubrication and improperly adjusted bearings cause overheating and damage to the equipment.

70. Air Compressor and Brakes

a. The air pump will be started slowly with the drain cocks open to allow the condensed water to escape. Since no provision is made in the steam end to cushion the piston at the end of its stroke, the air pump will be allowed to work slowly until a pressure

of 30 or 40 pounds has accumulated in the main reservoir. The drain cocks will then be closed and the throttle valve opened sufficiently to operate the compressor at the correct speed. The lubricator will be started when the pump is first put in operation. Air reservoirs will be drained at least once a day to remove condensation.

b. The steam end of the air pump will be oiled by the sight-feed lubricator at the rate of about 3 drops per minute. The air end will be oiled by means of the oil cups placed on the pumps for that purpose and by the swab on the piston. Valve oil will be used (Federal Specification No. VV-O-601).

c. Air compressor and air brake troubles.

(1) The following are common reasons for the pump stopping:

(*a*) The governor may be out of order.

(*b*) The reversing valve may be dry and in need of lubrication.

(*c*) Nuts on the piston rod may be loose or broken.

(*d*) One of the pistons may be pulled off.

(*e*) The reversing rod may be broken or bent.

(2) If, when the steam is first turned on, the piston makes a stroke up and stops:

(*a*) The shoulder of the reversing rod may be worn.

(*b*) The opening in the reversing plate may be too large to engage the shoulder on the reversing rod.

(*c*) The reversing plate studs may be loose, preventing the piston from traveling far enough to reverse the pump.

(*d*) The main valve may be stuck.

(3) If the piston makes a stroke up and a stroke down and stops:

(*a*) A reversing plate may be loose.

(*b*) The button on the lower end of the reversing rod may be worn or broken off.

(*c*) The nuts may be off the piston rod in the air end.

(*d*) The main valve may be stuck in its position at the left.

(4) If the governor fails to stop the pump at the proper pressure and the adjusting springs are properly set, the waste pipe to the governor may be frozen or stopped up.

(5) If the strainers are clogged with ice or dirt, the pump will run very fast and heat up and no air will be compressed. Strainers will be kept clean at all times.

(6) When a compressor short-strokes or dances, there is either too much oil in the steam end, a bent reversing rod, or low steam pressure, since then the governor has almost shut off the steam.

(7) If the handle of the brake valve does not operate freely, lubricate the rotary valve and key gasket with valve oil (Federal Specification No. VV-O-601) through the oil hole in the valve body. Also lubricate the side of the handle latch.

(8) If there is a leak at the brake pipe service exhaust port when the valve is in the release, running, or holding position, the trouble is probably caused by dirt on the seat of the brake pipe exhaust valve. This can usually be remedied by closing the cut-out cock below the brake valve and making a heavy service reduction, then returning the valve to release position. This will cause a strong blow at the service exhaust port which usually removes the dirt and allows the valve to seat.

(9) If the wheels start sliding when the driving brakes are applied, the brakes will be released and power used to start them rolling again. Do not sand to start as this will cause slidflat places on the driving wheels. Do not reverse the engine while the driver brakes are applied.

(10) The automatic brake is applied by reduction of brake pipe pressure and is released by restoring the brake pipe pressure. Breaking the train line causes an emergency application of brakes.

(11) The most common causes of brakes sticking on emergency application are overcharged train line or dirty feed valve. A stuck brake is bled off by holding the auxiliary release valve open until the brake piston starts to move to the release position.

71. Electric Headlight Dynamo

a. Before turning steam into the turbine, lubricate the bearings of the turbogenerator with lubricating oil. On the generator end, lubricating oil (U. S. Army Specification No. 2-60D) will be maintained within $\frac{1}{2}$ inch of the top of the hinge cover cup. Oil in generator oil cellar (U. S. Army Specification No. 2-60D) will be maintained at a sufficient level to allow the revolving oil ring to travel through the oil and properly lubricate the interior bearings.

b. The commutator will be cleaned and examined at each monthly inspection. If it is found to be cut or uneven, sandpaper will be used to smooth the commutator. Never use emery cloth since emery particles may lodge in grooves between commutator segments and, being a conductor of electricity, cause a short circuit. Particles of emery may also become embedded in the brushes and cut the commutator. After cleaning a commutator, mica segment separators may require undercutting to avoid short circuiting.

c. The commutator is the most vital part of the generator. It must be kept clean and the brushes

renewed frequently enough to prevent brush springs from contacting brush holders. New brushes will be fitted so that they have a bearing with the same contour as the commutator. This may be accomplished by placing a piece of fine sandpaper on the commutator surface and revolving the armature.

d. A generator that is short circuited will run slowly because it is under a heavy strain. It will be stopped until the trouble is corrected; if it is allowed to run in this condition, damage may result to the armature or field coils.

72. Inspection of Locomotive

a. In connection with the preparation of engine-men's and inspectors' daily reports on locomotives, it will be the daily duty and responsibility of maintenance personnel in all shops and engine houses to:

- (1) Check tools before dispatchment of locomotive.
- (2) Grease all alemite connections on the engine.
- (3) Fill all rod cups.
- (4) Inspect and pack engine truck boxes when necessary.
- (5) Inspect and pack driving box cellars when necessary.
- (6) Inspect and pack trailer truck boxes when necessary.
- (7) Inspect and oil all tender truck boxes and pack when necessary.
- (8) Test water glasses, water columns, gauge cocks, drippers, and injectors.
- (9) Test the brake equipment.
- (10) Inspect the boiler, firebox, flues, tubes and arch tubes for leaks.
- (11) Clean out tank hose and strainers.
- (12) Test the headlight and electrical equipment.
- (13) Examine telltale holes and clean if necessary.
- (14) Test sanders.
- (15) Clean the oil from the top of the fuel oil tank.
- (16) Test the oil burner with a steam atomizer to see if the steam cavity is open and that the burner is not cracked; also check the alignment of the burner.
- (17) Clean the fire pan boot and screen.

b. During the monthly inspection of the locomotive, it will be the duty of maintenance personnel also to—

- (1) Wash out and inspect the interior of the water tank, splash plates, and braces.
- (2) Grind in boiler checks and stop valves; pack valve stems.

(3) Grind in the blow-off cocks and renew the blow-off cock stem gaskets.

(4) Inspect the hydrostatic lubricator filling plugs and bushings.

(5) Examine and test the mechanical force feed lubricator, examine the ratchet rigging, and clean strainers.

(6) Check the mechanical lubricator feeds for standard settings.

(7) Examine the fire door and make the necessary repairs.

(8) Inspect and set up pedestal binders and wedges.

(9) Remove all rod collars and inspect bushings for wear.

(10) Inspect and tighten fuel oil tank anchor bolts.

(11) Gauge all driving and trailing tires, engine truck wheels for flange wear, distance back to back, and make inspection of all wheels.

(12) Examine all tank hose nuts and connections to insure that they are in good condition.

(13) Clean thoroughly, repair where necessary, and inspect all interior feed water strainers, tank valves and other connections, and interior of water tank, to insure that it is in good condition.

(14) Inspect, and repair where necessary, all injector starting valves, extension operating rods, latches, and the like.

(15) Remove and clean air brake feed valves.

(16) Remove the bonnet of the oil atomizer valve and inspect the valve stem threads on the stem and in the bonnet; also inspect the valve seat and disc, and renew if necessary.

(17) Unroll and examine all cab curtains; repair or renew if necessary.

(18) Examine exhaust nozzle bridges; and renew or repair if necessary.

c. In cleaning the locomotive during the monthly inspection period, it will be the duty of maintenance personnel to—

(1) At the place designated for this work on the incoming track, wash the tender trucks, the locomotive running gear, and that portion of the jacket which is underneath the running boards.

(2) For locomotives which are oily and dirty, prepare a solution for washing the sides of the cab, the tender, and the jacket above the running board. If jacket cannot be cleaned by wiping, dissolve one pound of approved make engine washing compound in about 3 gallons of hot water; stir until all engine washing compound is thoroughly dissolved and use as follows:

(a) Apply the cleaner with a round, short-hair

car scrub brush, rubbing the cleaner vigorously into the oil, dirt, and grime.

(b) Rinse off all dirt and cleaner with clean water, hot water preferred.

(c) If after rinsing, oily or dirty spots remain on the surface, at riveted joints or at corners, scrub these spots again with the cleaner and rinse until a clean surface is obtained.

(d) Apply cleaner only to a small surface at a time (that is, to one side of a cab or to a strip 2 or 3 feet wide for the height of the tender); then rinse off before it dries. If the cleaner is allowed to dry on a surface, the oil, dirt and grime which had been loosened will set, requiring application of more cleaner for removal.

(3) After the engine and tender are thoroughly clean, paint all dull or dingy surfaces on driving wheels, fronts of cylinders, cylinder jackets, and other parts of running gear which are usually painted. Use locomotive black paint and apply either by brushing or spraying. Paint blisters, rough spots, and all inert matter, will be removed from surfaces before painting.

(4) If the jacket is dingy, brush or spray a coat of locomotive black paint on freight locomotives.

(5) Brush the smoke box and the sides of the firebox under the cab which are painted with an approved make of front-end paint. Apply a new coat of front-end paint if necessary.

(6) Polish the bell and clean rods; hand wipe or paint the air pump and feedwater heater jackets.

d. During the quarterly inspection of a steam locomotive, which also includes work performed on daily and monthly inspection, maintenance personnel will:

- (1) Test steam gauge.
- (2) Clean steam gauge cocks and syphon cocks.
- (3) Anneal steam gauge syphon pipes.

(4) Examine valve and cylinder packing.

(5) Renew packing on all cab and fountain valve stems.

(6) Clean and brush smoke-box front end and firebox where parts are exposed; then paint and brush thoroughly.

(7) Clean, test, repair, and adjust the air pump governor.

(8) Remove, clean, and inspect water glasses (tubes or reflex glasses); renew any that are worn. Renew all water glass gaskets.

(9) Inspect and repair steam injectors.

(10) Examine grates and rigging; renew them if necessary.

e. During the semi-annual inspection of a steam locomotive, which also includes work performed on daily, monthly and quarterly inspections, maintenance personnel will:

(1) Examine and lubricate engine and tender truck center castings.

(2) Remove, clean and repair injectors.

(3) Remove and wash out all type of force feed lubricators; also remove and clean screens.

(4) Operate the force feed lubricator by hand to make sure that the pipes are open and free from leakage.

(5) Test mechanical lubricator terminal checks.

f. During the annual inspection of a steam locomotive, which also includes work performed on daily, monthly, quarterly, and semi-annual inspections, maintenance personnel will:

(1) Remove branch pipes, anneal copper pipes, and clean all scale. Examine boiler checks and clean.

(2) Whitewash all main and side rods and hammer with copper hammer.

(3) Inspect for cracks and other defects.

Section V. LOCOMOTIVES OUT OF SERVICE

73. Preparation of Locomotive for Storage

a. When a steam locomotive is prepared for storage, responsible personnel will:

(1) Remove all supplies such as market lamps, light globes, tool equipment, oil cans, seat cushions, and air brakes and signal hose.

(2) Drain all water from boiler and tender while the surfaces are still warm and remove all washout plugs to permit boiler to dry thoroughly. When a dry boiler cannot be assured because of atmospheric or other conditions, blow powdered soda ash into the

boiler until all surfaces have been dusted. Take precautions against leaving boilers filled with water during storage where freezing temperatures are encountered.

(3) Drain feedwater pump, lubricators, air pumps, injector pipes, turbogenerators, and all other pipes where water may accumulate to cause rust or freezing with consequent blow out of heat units. Disconnect tank hose between engine and tender.

(4) Cover with reclaimed journal box oil or other suitable rust preventive, all side and main rods, valve gear parts, guides, piston rods, throttle and

reverse levers and quadrants, piston rods on air compressors and feedwater pumps, and all other outside finished parts.

(5) Paint boiler jacket with a suitable rust preventive during the rainy season.

(6) When locomotive is stored some distance from roundhouse or where parts may be stolen, board up the cab and headlight to protect them from damage.

(7) Examine locomotive after heavy rains and cover again with rust preventive if necessary.

(8) Move locomotives in storage periodically to keep the cylinders, valve chests and other parts lubricated. Connect air compressors and feedwater pumps to air line and operate for a short time to distribute lubrication.

b. To protect equipment from freezing when a steam locomotive is not in service, is awaiting assignment, or is in temporary storage, responsible personnel will—

(1) Blow out all water from the cylinder units, steam pipes, passages, and channels. Secure stack covers on top of smoke stack. Drain air pumps, remove reversing rod valve cap nut, and pour a small quantity of light oil in reversing valve chamber.

(2) Take the following precautions at the beginning of freezing weather: Clean and test all steam heat reducing valves; test the steam heat pressure gauge at time of cleaning valve; inspect all steam heat metallic connections on locomotives under steam pressure.

(3) Drain at frequent intervals water and foreign matter from main reservoir and from all other parts of equipment. Keep air compressors moving slowly in freezing weather and keep partly open all drain cocks, cut-out cocks and angle cocks so that circulation of air will prevent freezing.

74. Movement of Locomotive "Dead on Wheels"

To prevent damage and unnecessary deterioration when a steam locomotive is processed for movement "dead on own wheels," responsible personnel will—

a. Remove the main and eccentric rods, except where they are required to operate the mechanical lubricating system of the running gear. Give rods a heavy coating of grease.

b. Move crossheads to the extreme front end of the guides and secure them in this position with a block 2 inches thick and in width equal to that of the guide. Fasten the blocks to the guide by wrapping metal strips not less than 20-gauge in thickness and 1 inch in width around the block and guide, securely nailing the strips to the block. Place at least four of these strips around each block, spacing them equal distances apart.

c. Place the main valve in the center so that reciprocating parts of the valve gear will be about equally balanced and clamp in that position. Where mechanical lubricators are used, the link will be placed off-center.

d. Take two blocks of wood 12 inches in width by 6 inches in thickness and the length equal to that of the main rod bearing; fasten together with two $\frac{5}{8}$ inch bolts; bore a hole the diameter of main pin and apply to main pin to fill space between eccentric crank and main connection. Or take pieces of lumber from $\frac{3}{4}$ inches to $1\frac{1}{4}$ inches thick, approximately $1\frac{1}{2}$ inches wide and the length of the back end main rod bearing and nail a sufficient number of these strips with the ends parallel about 1 inch apart, to two metal strips not less than 20-gauge material, approximately 1 inch wide. Then wrap this around the main bearing and secure by nailing the ends of the metal strips to the wood, this band thereby acting as a spacer between the eccentric crank arm, or main crank pin collar, and the middle connection rod bearing.

e. Where mechanical lubricators are used en-route, remove pistons and piston rods, coat cylinder walls with rust preventive, and replace cylinder heads. Seal piston rod opening in back heads with oiled paper and wood blocks. Coat pistons, piston rings and piston rods with rust preventive, wrap with water proof paper, and box. Place the valve on center and lock. Remove the eccentric rod and place link blocks off center. Never blank off lubricator feeds to cylinders and valve chambers as this will break lubricator pumps.

f. Oil shoes and wedges, fill rod cups and see that packing in all boxes is in good shape.

g. Load on the engine all parts removed and block them securely.

h. During winter months, drain completely all pipes, air pumps, feed water pumps, lubricators, boilers and tenders.

i. Block handles of both brake valves in running position. Close and fasten double-heading or cut-out cock under brake valve. Clean dead engine fixture and open cut-out to it.

j. Reduce the adjustment of the safety valve on the distributing valve whenever absence of water in the boiler, or other reason, justifies keeping the maximum braking power lower than the standard.

k. Equip "dead" locomotives with side rods in position; inspect to determine if locomotive is safe for movement in tow, then haul in freight trains limited to a speed of 15 miles per hour.

l. If "dead" locomotives are not fully equipped with air brakes, the following definite set-up for

handling the equipment will be followed in the zone of the interior. Operating personnel will—

(1) Equip each locomotive with a standard pivoted-type coupler, front and rear ends.

(2) Equip each locomotive with an F-2 plain-acting, triple valve joined to one of the main reservoirs which will serve as an auxiliary reservoir, and connect with the locomotive and tender brake cylinders. Disconnect the drain and plug the hole of the steam brake cylinder on the tender. Set the brake-pipe pressure at 90 pounds.

m. In the make-up of the train for movement, personnel will—

(1) Space four idler cars between the hauling locomotive and the first "dead" engine in the train.

(2) After the first "dead" engine, space two idler cars between each of the "dead" engines in the train.

(3) Space two idler cars between the last "dead" engine and the cabin car.

(4) Determine the number of "dead" engines to be handled by the physical characteristics and operating conditions on the railroads over which the "dead" locomotives are moved.

n. If circumstances require backward hauling of "dead" locomotives equipped for road service, turn locomotive at the first point where there are facilities for doing so. Limit speed of train to 10 miles per hour until properly headed.

o. Designate messenger or pilot to accompany the locomotive and tender to its shipping destination. Such pilot must know the working parts of the running gear, make frequent inspections enroute, watch for hot pins and bearings; apply a good grade of engine oil to all wearing parts, including shoes and wedges; lubricate properly other parts of the locomotive; make a written report of the running condition to the officer at receiving station, and obtain a receipt for delivery of the locomotive.

75. Preparation of Locomotive for Ocean Transit

In case it is necessary to prepare erected steam loco-

motives for oversea shipment, detailed instructions will be issued by proper authority.

76. Care During Layover Periods

a. It will be the duty and responsibility of the engineer or operator, who places a locomotive or crane at the completion of work, to block the driving wheels with suitable block or chain.

b. With steam equipment it will be his duty also to:

(1) Place reverse lever on center or neutral position.

(2) Properly close main throttle.

(3) Open cylinder cocks.

(4) Shut off steam supply to air pumps.

(5) Drain main reservoirs of all condensation.

(6) If so equipped, to open manually operated relief cocks in valve chambers as additional precaution.

c. It will be the duty and responsibility of the hostler while equipment is in his charge, to determine:

(1) That driving wheels are properly blocked to prevent moving.

(2) That main throttles are maintained in close positions.

(3) That cylinder cocks and relief cocks, if so equipped, are maintained in open positions.

(4) That reverse levers are maintained in center or neutral position.

d. A locomotive or locomotive crane under steam will not be left unattended. Do not bank fires with an excessive amount of coal for the night. A competent person will be assigned to watch the engine or crane when it is idle. Lack of proper attention may result in burned boilers due to low water. In cold weather the watchman will be held responsible for maintaining a sufficient fire to prevent freezing of the boiler appurtenances or damage to the equipment.

REGULATIONS GOVERNING INSPECTION AND TESTING OF LOCOMOTIVES, OTHER THAN STEAM

Section I. BRAKE EQUIPMENT

77. Air and Vacuum Brakes (Rule No. 101)

Before each trip it will be ascertained that the brakes are in safe and suitable condition for service; that the air compressor or compressors are in condition to provide an ample supply of air for the service into which the locomotive is placed; that the devices for regulating all pressures are properly performing their functions; that the brake valves work properly in all positions; and that the water has been drained from the air-brake system.

78. Safety Valves (Rule No. 102)

a. The main reservoir system of each unit will be equipped with at least one safety valve of a capacity sufficient to prevent an accumulation of pressure of more than 10 pounds per square inch above the maximum working air pressure fixed for the unit operating the locomotive by the Zone Master Mechanic, zone of the interior, or by the Railway Grand Division headquarters, theater of operations.

b. A suitable governor will be provided that will stop and start the air compressor within 5 pounds above or below the pressure fixed.

c. The compressor governor, when used in connection with the automatic air-brake system will be so adjusted that the compressor will start when the main reservoir pressure is not less than 15 pounds above the maximum brake-pipe pressure fixed by the chief of transportation, and will not stop the compressor until the reservoir pressure has increased not less than 10 pounds.

d. The compressor or compressors will be tested for capacity by orifice test as often as conditions may require, but not less frequently than once every three months. This time limit may be increased if upon application to the zone master mechanic, zone of interior, or to the railway grand division headquarters, theater of operations, investigation shows that conditions warrant it.

e. The minimum capacity of any compressor per-

mitted in service will be approximately 80 percent of the capacity of the compressor when new. The diameter of orifice, speed of compressor, and air pressure to be maintained for compressors in common use is shown in tables in appendix II (For diagram of orifice see fig. 14.)

79. Hydrostatic Test of Main Reservoirs (Rule No. 103)

a. Every main reservoir before being put into service, unless new, and at least once every 12 months thereafter, will be subjected to hydrostatic pressure of not less than 25 percent above the maximum working pressure fixed by the chief mechanical officer, and a report made on WD AGO Form 55-230. (See chapter 12.)

b. The entire surface of each main reservoir will be hammer tested each time the locomotive is shopped for general repairs, but not less frequently than once every 24 months, and a report made on WD AGO Form 55-230. This test will be made while the reservoir is empty.

80. Air Gauges (Rule No. 104)

a. Air gauges will be so located that they may read conveniently by the engineer or motorman from his customary position in the cab.

b. Air gauges will be tested at least once every 3 months, and whenever any irregularity is reported. They will be compared with an accurate deadweight tester, or test gauge constructed for the purpose of testing gauges, and gauges found incorrect will be repaired before they are returned to service.

81. Cleaning (Rule No. 105)

a. Distributing or control valves, reducing valves, triple valves, transfer valves, straight-air double-check valves, brake-pipe vent valves, and dirt collectors, will be cleaned as often as conditions require to maintain them in a safe and suitable condition for service, but not less frequently than once every 6 months.

b. The date of testing or cleaning, and the initials of the shop or station at which the work is done, will be stenciled legibly in a conspicuous place on the parts, or placed on a card displayed under glass in the cab of each locomotive.

82. Piston Travel (Rule No. 106)

a. Minimum brake cylinder piston travel will be sufficient to provide proper brake shoe clearance when the brakes are released.

b. The maximum piston travel, when locomotive is standing, will not exceed 6 inches for brakes on driving wheels when journal boxes are provided with shoes and wedges. When shoes and wedges are not provided the maximum piston travel may be 7 inches.

c. On swivel trucks where the brakes on more than one truck are operated by the same cylinder, the maximum piston travel will not exceed 7 inches. Where the cylinder operates the brakes on one truck only, the maximum piston travel may be 8 inches.

83. Foundation Brake Gear (Rule No. 107)

The foundation brake gear will be maintained to the

standard for the locomotive. Levers, rods, brake beams, hangers, and pins will be of ample strength, and will not be fouled in any way which will affect the proper operation of the brake. All pins will be properly secured in place with cotters, split keys, or nuts. Brake shoes will be properly fastened in place, and kept approximately in line with the tread of the wheel.

84. Main Reservoir Leakage (Rule No. 108)

a. Leakage from main air reservoir and related piping will not exceed an average of 3 pounds per minute in a test of 3 minutes' duration, made after the pressure is reduced 40 percent below the maximum pressure.

b. Brake-pipe leakage shall not exceed 5 pounds per minute at any time.

c. With a full service application from maximum brake pipe pressure, and with communication to the brake cylinders closed, the brakes will remain applied not less than 5 minutes, otherwise brake cylinder leakage is indicated.

Section II. DRAWGEAR AND RUNNING GEAR

85. Drawgear and Connections (Rule No. 109)

a. Drawgear between units of any locomotive and connections between trucks will be of ample strength and will be maintained in a safe and suitable condition for service.

b. Provisions will be made for securing draw-bar pins and pins of articulated connection in place, and a plate or stirrup will be provided under the lower end of all draw-bar pins and articulated connection pins which will prevent the pin from falling out of place in case of breakage.

c. Drawbars and pins when used between units of any locomotive will be removed as often as conditions may require, but not less frequently than once every 6 months. When used between trucks they will be removed each time the locomotive is shipped for general or echelon repairs, but not less frequently than once every 18 months. When drawbars and pins are removed, they and their connections will be inspected carefully for defects. Date of last removal and inspection will be stamped legibly on the heads of the pins and draw bars and all prior dates obliterated.

d. Lost motion in articulated connections when

used between units of any locomotive or between trucks will be kept to a minimum and will not exceed $\frac{1}{4}$ inch at each pin. Pins of articulated connections between units of any locomotive will be removed not less frequently than once every 6 months, and pins of articulated connections between trucks will be removed not less frequently than once every 18 months. When articulated connection pins are removed, they and their connections will be inspected carefully for defects. Date of last removal and inspection will be stamped legibly on the heads of the pins and all prior dates obliterated.

e. When draw bars are used between units of any locomotive, chafing irons or spring buffers that permit proper curving will be provided, be properly attached to each unit, and be maintained in condition to permit free movement laterally and vertically. Lost motion between chafing irons will be kept to a minimum but must not exceed $\frac{1}{2}$ inch. Buffer springs will be applied with not less than $\frac{3}{4}$ -inch compression and will at all times be under sufficient compression to keep the chafing faces in paper alignment and contact; for drawbars designed and constructed for the purpose of taking buffing stresses, chafing irons or spring buffers will not be required. When such drawbars are used the lost

motion will be kept to a minimum, but will not exceed $\frac{1}{4}$ inch at either end.

f. Drawgear between units of any locomotive consisting of automatic couplers with friction or spring draft gear will be maintained in such condition that the lost motion in each draft gear assemblage, not absorbed by the springs of friction devices, will not exceed $\frac{1}{2}$ inch.

g. Drawgear between units of any locomotive consisting of automatic couplers without friction or spring draft gear will have lost motion kept to a minimum and lost motion between coupler and coupler pocket will not exceed $\frac{1}{4}$ inch in each assemblage. If the couplers are attached by means of pivot pins, the pins will be removed and inspected not less frequently than once every 6 months and date of last removal and inspection of pins will be stamped legibly on the heads of pins and all prior dates obliterated.

h. Draft gear and attachments of locomotives will be securely attached, be of ample strength, and be maintained in a safe and suitable condition for service, including couplers and all operating mechanism. Standard couplers measuring $5\frac{1}{8}$ inches or more between point of knuckle and guard arm will not be continued in service.

86. Running Gear

a. AXLES (RULE No. 110). Driving and truck axles with any of the following defects will not be continued in service: Cracked or bent axles, cut journals that cannot be made to run cool without turning; seamy journals in steel axles; transverse seams in iron axles or any seams in iron axles causing journals to run hot; driving and truck axles unsafe on account of usage, accident, or derailment; driving or truck axles more than $\frac{1}{2}$ inch under original diameter, except for locomotives having all driving axles of the same diameter, when other than main driving axles may be worn $\frac{3}{4}$ inch below the original diameter.

b. CRANK PINS (RULE No. 111). (1) Crank pins will be applied securely. Shimming or prick punching crank pins will not be done. Cracked or loose crank pins will not be continued in use.

(2) Crank-pin collars and collar bolts will be kept tight. Diameter of crank-pin collars will be greater than the bore of the rod on the pin to which it is applied, except where a collar is made integral with the outer end of the bushings.

c. MOTOR, MAIN AND SIDE RODS (RULE No. 112).

(1) Cracked or defective motors, main, or side rods will not be continued in service.

(2) Bearings and bushings will fit the rods prop-

erly and means provided to prevent bushings, other than floating bushings designed to turn, from turning in rods. Straps will fit and be securely bolted to rods.

(3) The total amount of side motion of rods on crank pins will not exceed $\frac{1}{4}$ inch.

(4) Oil and grease cups will be attached securely to rods, and grease-cup plugs be equipped with suitable fastenings.

(5) The bore of motor rod or main rod bearings on locomotives used in road service will not exceed pin diameters more than $\frac{3}{32}$ inch at front or back end. The total lost motion at both ends will not exceed $\frac{5}{32}$ inch.

(6) The bore of side rod bearings on locomotives used in road service will not exceed pin diameters more than $\frac{5}{32}$ inch on main pin nor more than $\frac{3}{16}$ inch on other pins.

(7) The bore of motor rod or main rod bearings on locomotives used in switching service will not exceed pin diameters more than $\frac{1}{8}$ inch at front and not more than $\frac{5}{32}$ inch at back end.

(8) The bore of side rod bearings on locomotives used in switching service will not exceed pin diameters more than $\frac{3}{16}$ inch.

d. JACK SHAFTS (RULE No. 113). (1) Jack shafts will be counterbalanced properly, crank arms and discs will fit properly and be fastened securely on shaft.

(2) When motor rods are connected direct to jack shaft crank arms or discs, the bore of shaft bearings will not exceed journal diameter more than $\frac{1}{16}$ inch. When the motor drive is geared, the bore of shaft bearings will not exceed journal diameter more than $\frac{1}{8}$ inch.

e. QUILL DRIVE (RULE No. 114). (1) Quills will have sufficient clearance for relative motion of axle and wheel. Drive pins will be securely applied.

(2) Quills with any of the following defects will not be continued in service: Cracked or loose drive pin; broken or defective quill coil springs; broken or defective quill gear spring seat, saddle or fastenings.

f. GEAR GUARDS (RULE No. 115). (1) Exposed gears will be provided with safe and suitable guards.

(2) Gears or pinions with any of the following defects will not be continued in service: Gear or pinion loose on shaft; gears or pinions broken, cracked, or with badly worn teeth; gears or pinions broken or with defective rim fastenings; gears or pinions out of alignment or improperly meshed; split gears with loose or missing bolts.

g. DRIVING BOXES, SHOES AND WEDGES (RULE No. 116). Driving boxes, shoes and wedges will be

maintained in safe and suitable condition for service; broken and loose bearings will be renewed. Not more than one shim will be used between box and bearing if bearing is pressed in box.

h. LATERAL MOTION (RULE No. 117). The total lateral motion between the hubs of the wheels and boxes on any pair of wheels will not exceed the following limits: truck wheels, 1 inch; driving wheels, more than one pair of wheels, $\frac{3}{4}$ inch. These limits may be increased if, upon application to the zone master mechanic, zone of interior, or to the railway grand division headquarters, theater of operations, investigation shows that conditions require additional lateral motion. The lateral motion will in all instances be kept within such limits that the driving wheels, rods, crank pins, or armatures will not interfere with other parts of the locomotive.

i. FRAMES AND PARTS (RULE No. 118). Frames, deck plates, tail-pieces, pedestals, and braces will be maintained in safe and suitable condition for service, and will be cleaned and inspected thoroughly each time the locomotive is in shop for general or echelon repairs.

j. SPRING RIGGING (RULE No. 119). (1) Springs and equalizers will be arranged to insure the proper distribution of weight, cushion of shocks to the various wheels, and be maintained approximately level.

(2) Springs or spring rigging with any of the following defects will be renewed or repaired properly: Top leaf broken or two leaves in top half or any three leaves in spring broken (the long side of spring to be considered the top); springs with leaves working in band; broken coil springs; broken, cracked, or badly worn driving-box saddle, equalizer, hanger, bolt, gib, or pin.

k. TRUCKS (RULE No. 120). (1) Truck center plates will fit properly, and the male center plate extend into the female center plate not less than $\frac{3}{4}$ inch, except on motor trucks constructed to transmit tractive effort through center plate or center pin, when the male center plate will extend into the female center plate not less than $1\frac{1}{2}$ inches and the center plate will be fastened and maintained securely.

(2) Center pins with substantial head, key, or nut at each end, or other suitable means that will hold the carrying bolster on the truck will be provided. All centering devices will be maintained properly.

(3) A suitable safety chain of minimum consistent length will be provided at each corner of all

four-wheel trucks except where construction prevents truck sluing in case of derailment.

(4) All parts of trucks will have sufficient clearance to prevent them from seriously interfering with any other part of the locomotive.

(5) Truck bolsters will be maintained approximately level.

(6) Suitable means for securing radius bar pins in place will be provided. Inverted radius bar pins will be held in place by plate or stirrup.

(7) Trucks with any of the following defects will not be continued in service: cracked arch bar; loose column, pedestal or journal-box bolt; cracked or broken frame, unless properly repaired; loose tie bar; broken or defective motor suspension lug, spring, bar, or bolt; broken or cracked center casting; cracked or broken equalizer, hanger, gib, or pin.

(8) Motor suspension lugs or bars will be of ample strength and provision made that will prevent nose-supported motors from falling in case of failure of motor supports.

l. SIDE BEARINGS (RULE No. 121). (1) Side bearings will be fastened securely in place. Friction side bearings with springs designed to carry weight will not be continued in service with more than 25 percent of the springs broken in any one nest.

(2) Friction side bearings, unless designed to carry weight, will not be run in contact. Maximum clearance of side bearings will not exceed $\frac{1}{4}$ inch on each side, or a total of $\frac{1}{2}$ inch on both sides, except where more than two side bearings are used under the same rigid super-structure, when the clearance on one pair of side bearings under the same rigid super-structure will not exceed $\frac{1}{4}$ inch on each side or a total of $\frac{1}{2}$ inch on both sides. The other side bearings under the same rigid super-structure may have $\frac{1}{2}$ inch clearance on each side or a total of 1 inch on both sides. These clearances apply where the spread of the side bearings is 50 inches or less. Where the spread is greater, the side bearing clearance may be increased in proportion. Side bearing clearances may be modified if investigation shows that operating conditions and construction warrant such modification.

m. CLEARANCE ABOVE TOP OF RAIL (RULE No. 122). No part or appliance of locomotive, except the wheels, will be less than $2\frac{1}{2}$ inches above the top of rail.

Section III. WHEELS

87. Wheels Tight on Axle (Rule No. 123)

a. Wheels will be pressed securely on axles, except wheels and axles of special design and construction where other proper and safe means are provided for holding the wheels on the axles. Prick punching, shimming wheel fit, or driving pins in ends or axles will not be done.

b. When wheels or tires are applied, or wheels or tires are turned, the diameter of the wheels on the same axle will not vary more than $\frac{3}{32}$ inch. When all tires are turned or new tires applied to driving wheels in rod-connected driving-wheel bases the diameter of such tires will not vary more than $\frac{3}{32}$ inch. When a single pair of tires is applied in a rod-connected driving-wheel base the diameter of such tires will be within $\frac{3}{32}$ inch of the average diameter the other tires in the same driving-wheel base.

c. Wheels used on standard-gauge track will be out of gauge if the inside gauge of flanges, measured on base line, is less than 53 inches or more than 53½ inches.

d. The distance back to back of flanges of wheels mounted on the same axle will not vary more than $\frac{1}{4}$ inch.

e. Wheel centers with divided rims will be fitted properly with iron or steel filling blocks or autogenously welded before the tires are applied, and will be maintained properly.

f. When shims are inserted between the tire and the wheel center, not more than two thicknesses of shim may be used, one of which will extend entirely around the wheel. Shims which extend entirely around the wheel may be in one or more pieces, provided they do not overlap. Under no circumstances will there be more than two thicknesses of shim at any point.

g. Counterbalance will be maintained in safe and suitable condition for service.

h. On locomotives used in road service the minimum height of flange measured from tread will be 1 inch and on switching locomotives will be $\frac{7}{8}$ inch, except where construction does not permit the full height of flange on all driving wheels in any rigid wheel base, the height of flange on at least two pairs of drivers will be not less than 1 inch for road locomotives; the other may have flanges with minimum height of $\frac{5}{8}$ inch. Where plain tires or $\frac{5}{8}$ inch

flanges are used on front or rear drivers, trucks will be provided for safely guiding the locomotive.

i. The maximum taper for tread of driving wheels from throat of flange to outside of wheel for locomotives used in road services will be $\frac{1}{4}$ inch and for locomotives used in switching service $\frac{5}{16}$ inch. The maximum taper for tread of truck wheels from throat of flange to outside of wheel will be $\frac{5}{16}$ inch.

j. The minimum width of tires for driving and truck wheels of standard gauge locomotives will be 5½ inches for flanged tires, and 6 inches for plain tires. The minimum width of tires for driving and truck wheels for narrow-gauge locomotives will be 5 inches for flanged tires, and 5½ inches for plain tires.

k. The limits prescribed in *c*, *h*, and *j* above may be modified if, upon application to the commanding officer, investigation shows that conditions warrant such modification.

88. Wheel Defects (Rule No. 124)

Wheels with any of the following defects will not be continued in service:

a. Slid flat, when the flat spot is 2½ inches or over in length, or if there are two or more adjoining spots each 2 inches or over in length.

b. Broken or chipped flange, if the chip exceeds 1½ inches in length and $\frac{1}{2}$ inch in width.

c. Broken rim, if the tread, measured from the flange at a point $\frac{5}{8}$ inch above the tread, is less than 3¾ inches in width.

d. Wheels with defective treads on account of cracks or shelled-out spots 2½ inches or over, or so numerous as to endanger the safety of the wheel.

e. Any seam running lengthwise and within the limit of 3¾ inches from the flange, as shown in figure 13.

f. Wheels with flanges having flat vertical surface extending 1 inch or more from the tread, or flanges $\frac{15}{16}$ inch thick or less, gauged at a point $\frac{3}{8}$ inch above the tread, except cast-iron or cast-steel wheels on axles with journals 5 by 9 inches or over, which will not be continued in service with flanges having flat vertical surface extending $\frac{7}{8}$ inch or more from the tread, or flange 1 inch thick or less gauged at a point $\frac{3}{8}$ inch above tread.

g. Wheels with tread worn hollow $\frac{5}{16}$ inch on locomotives used in road service or $\frac{3}{8}$ inch on loco-

motives used in switching service. For method of gauging see figures 15 and 16.

h. Wheel cracked outward from the wheel-fit; cracked tread; cracked plate; one or more cracked brackets; wheel loose on axle.

i. Loose, broken, or defective retaining rings, tires, or bolts.

j. Three adjacent spokes or 25 percent of the spokes in wheel broken.

k. Flanges more than $1\frac{1}{2}$ inches from tread to top of flange or thickness of tires or rims less than shown in figures 1, 2, 3, 4, 5, 6, and 7.

l. Wheels or tires out of gauge.

m. Rolled steel wheel $1\frac{3}{8}$ inches or less in thickness through throat of flange, or 1 inch or less in thickness at rim, when used in road service; or $1\frac{1}{8}$ inches or less in thickness through throat of flange or $\frac{3}{4}$ inch or less in thickness at rim, when used in switching service.

n. The limits shown in *k* and *l* above and figures 1, 2, 3, 4, 5, 6, and 7 may be modified if, upon application to the commanding officer, investigation shows that conditions warrant such modifications.

(*Note.* See figures 8, 9, 10, 11, 12, 13, 15, and 16 for gauging and methods of gauging.)

89. Minimum Tire Thickness (Rule No. 125)

a. For minimum thicknesses for driving wheel tires on standard and narrow gauge locomotives, see chapter 4.

b. When retaining rings are used, measurements of tires will be taken from the outside circumference of the ring, and the minimum thickness of tires may be as much below the limits specified above as the tires extend between the retaining rings, provided it does not reduce the thickness of the tires to less than $1\frac{1}{8}$ inches from the throat of flange to the counter bore for the retaining ring.

c. The minimum thickness for driving-wheel tires will be 1 inch for locomotives operated on track of 2 foot gauge.

d. The thickness of tires, when weight per axle is less than 30,000 pounds, may be modified if upon application to the commanding officer, if investigation shows that conditions warrant such modifications.

Section IV. CABS, LIGHTS, WHISTLES, BELLS, SANDERS, AND SIGNALS

90. Cabs (Rule No. 126)

a. The word "cab" as used in these rules and instructions means that portion of the super-structure utilized for housing the enginemen and parts of the locomotive and through which a passageway is provided for the use of the enginemen.

b. Cabs and super-structures will be attached securely and braced. Cab windows will be located and maintained so that the enginemen will have a clear view of track and signals from their usual and proper positions in the cab.

c. Front cab doors or windows which are in line of enginemen's vision when they look ahead from their usual and proper positions in the cab, will be equipped with an appliance that will clean the outside of the windows over sufficient space to provide a clear view of tracks and signals ahead. They may be equipped with a window which is hinged at the top and is so placed in the glass of each of the doors or windows, that it can be closed or opened and fastened in desired position into the cab. Hinged windows will be 5 inches high, and the lower edge will be without obstruction and as nearly as possible in line with the engineman's vision when he is seated in the cab.

d. Deck plates and floors of cab passageways and compartments will be kept free from accumulations of oil, waste, or any obstructions that create unnecessary hazards. Deck plates and metal floors will be roughened properly, or other provisions made to afford secure footing.

e. Floors of enginemen's compartments will be constructed of or covered with heat-insulating material.

f. Enginemen's compartments will be provided with heating arrangements that will maintain therein a temperature of not less than 50° F. Temperature will be taken at substantially the center of the compartment under normal winter weather conditions, under the running conditions of the locomotive, and with doors and windows closed.

g. Aprons or cover plates when used between units or compartments will be of proper length and width to insure safety. They will be hinged or fastened securely, and roughened or other provision made to afford secure footing.

91. Lights

Note. If locomotive is equipped and operated in blackout areas both headlight and cab light will be disconnected.

a. HEADLIGHTS (RULE No. 127). (1) Each loco-

motive in road service between sunset and sunrise will be equipped with a headlight of sufficient illumination to permit sight, in a clear atmosphere, of a dark man-size object at least 800 feet in front of the headlight by a person in the cab of the locomotive. Such headlight will be maintained in good condition.

(2) Each locomotive in road service, which regularly is required to run backward for any portion of its trip, except to pick up a detached portion of its train or in making terminal movements, will be equipped with a headlight which meets the requirements of (1) above.

(3) Such headlight described in (1) and (2) above will be provided with a device whereby the light may be diminished at stations and in yards, or when meeting trains.

(4) When two or more locomotives are used in the same train, the leading locomotive only will be required to display a headlight.

(5) Each locomotive used in yard service between sunset and sunrise will have two lights, one located on front of the locomotive and one on the rear. Each headlight will be of sufficient power to enable a person in the cab of the locomotive under the conditions, including visual capacity, set forth in (1) above, to see a dark object such as there described for a distance of at least 300 feet ahead and in front of such headlight. Such headlights will be maintained in good condition.

b. CLASSIFICATION OR MARKER LIGHTS (RULE No. 128). Each locomotive will be provided with such classification and marker lamps as may be required by the transportation officer. When such lamps are used they will be maintained in good working order; classification lights will be lighted electrically.

c. CAB LIGHTS (RULE No. 129). (1) Each locomotive unit will have cab lights which will provide sufficient illumination for the control instruments, meters, and gauges to enable the enginemen to make accurate readings from their usual and proper positions in the cab. These lights will be located, constructed, and maintained so that light will shine only

on those parts requiring illumination. There will be a light conveniently located to enable personnel operating the locomotive to read easily and accurately train orders and time tables, and constructed so that it may be darkened or extinguished readily.

(2) Cab passageways and compartments will have adequate illumination. When persons are required to pass from one cab to another, the platform or passageway between them will be illuminated.

(3) Lights will be located, constructed, or shielded so that the light will not interfere with enginemen's vision of track and signals.

(4) All lights may be supplied entirely from storage batteries if desired. Where lights are not supplied from storage batteries, there will be two or more lighting circuits for providing illumination required by (1), (2), and (3) above. Battery containers will be properly vented.

92. Whistles, Bells, Sanders, Train Signal

a. WHISTLE (RULE No. 130). Each locomotive will be provided with a suitable whistle, or its equivalent, and located so that it may be operated conveniently by the engineer or motorman from his customary position in the cab.

b. HEADLIGHTS, SAND BOXES, BELLS AND WHISTLES (RULE No. 131). These will be located in safe and accessible places. Where locomotives are equipped with overhead current collectors, headlights and sand boxes will be located, constructed, and arranged so that they may be given the necessary repairs and attention without requiring a person to mount the roof or become exposed to contact with parts carrying high-tension electric current.

c. SANDERS (RULE No. 132). Each locomotive unit will be equipped with proper sanding apparatus. Sandpipes shall be fastened securely and arranged to deliver the sand on the rails in front of the wheel contact. Sanders will be tested before each trip.

d. TRAIN SIGNAL SYSTEM (RULE No. 133). The train signal system, when used, will be tested before each trip and maintained in safe and suitable condition for service.

Section V. ELECTRICAL EQUIPMENT

93. Current Collector Insulation (Rule No. 134)

a. Current collectors will be insulated adequately from the locomotive structure for the maximum voltage carried by the conductor.

b. Pantagraphs will be arranged so that they can be operated from the engineer's or motorman's usual and proper place in the cab.

c. Pantagraphs which automatically rise when released will be provided with an automatic locking

device that will hold them while in down position.

d. Each pantagraph operating on an overhead trolley wire will be provided with a device for locking and grounding the pantagraph when in lowest position, which can be applied and released only from a position where the operator will have a clear view of pantagraph and roof without mounting the roof.

e. Pantagraph shoes with cracked or badly worn contact surface or with defective horn will not be continued in service.

f. Leaky or defective pantagraph operating cylinder, connection, or air hose will not be continued in service; air hose will be of sufficient length to afford proper insulation.

94. Trolley Hooks and Insulation (Rule No. 135)

a. A trolley-pole hook substantially bolted in place and adequately insulated from the locomotive structure will be provided that will hold the pole while in down position.

b. When a locomotive is equipped with more than one trolley pole, each pole will be equipped with a device for grounding the pole when it is secured by the hook referred to in *a* above, which can be applied and released only from a position where the operator will have a clear view of the trolley pole and roof without mounting the roof.

c. Each trolley pole will be provided with a suitable rope. A retriever or trolley catcher will be provided for the pole used while the locomotive is in motion unless rope is under constant observation.

d. Where trolley wire carries more than 750 volts, each trolley rope will be insulated from the pole for the maximum voltage carried by the trolley wire. Trolleys with badly burned or warped harps and broken, badly burned or worn wheels, will not be continued in service.

95. Deenergized Shoes (Rule No. 136)

a. When locomotives are equipped with both third rail and overhead collectors, third rail shoes will be deenergized while in yards and at stations when current collection is from overhead conductor and not intermittent from third rail and overhead.

b. Third-rail shoe beams loose on brackets, split or cracked, or with accumulations of extraneous matter conducive of short circuits will not be continued in service.

96. Emergency Pole (Rule No. 137)

a. Each locomotive equipped with a pantagraph operating on an overhead trolley wire will have a suitable emergency pole for operating the pantagraph and the part which can be safely handled will be

marked. This pole will be protected from moisture while not in use.

b. Each locomotive equipped with third rail shoes will have a suitable device for insulating current collecting apparatus from third rail when desired.

97. Lightning Arrester (Rule No. 138)

a. Where current supply is continuously taken from an overhead conductor and lightning protection is not provided along the line of road that will afford adequate protection for the locomotive, each locomotive unit will be provided with a suitable lightning arrester. In sections where freezing weather is encountered, a lightning arrester will not be required on locomotive units between 1 November and 1 March. The current-collector cable will be tapped for the lightning arrester at a point as near the overhead current collector as possible.

b. The lightning arrester will have an adequate grounding conductor of not less than No. 6 American wire gauge, run in as straight a line to ground as possible, and protected against mechanical injury, but not run in metal conduit.

98. Grounding of Metal Parts (Rule No. 139)

All unguarded noncurrent-carrying metal parts which are subject to becoming charged electrically and which are not thoroughly insulated will be grounded.

99. Guard Current-carrying Parts (Rule No. 140)

All current-carrying parts connected to circuits with potential of more than 150 volts will be isolated, insulated, or guarded against accidental contact.

100. Doors and Cover Plates Marked "Dangerous" (Rule No. 141)

All doors and cover plates guarding high tension equipment will be securely fastened in place, and kept marked with the word "DANGER" and stating the normal voltage carried by the parts so protected.

101. Hand-operated Switches (Rule No. 142)

a. All hand-operated switches carrying currents with a potential of more than 150 volts, which may be operated while under load, will be inclosed in a cabinet or properly covered and be operative from the outside; means will be provided also to show whether switches are open or closed. Switches which may not be operated while under load will be guarded against accidental contact and kept plainly marked with the words "*must not be operated under load*" and stating the voltage carried.

b. Circuit breakers, contactors, and fuses will be maintained in safe and suitable condition for service

and will be so located or guarded that persons may not be injured by their operation.

c. Oil-type circuit breakers will be maintained in safe and suitable condition.

102. Jumpers (Rule No. 143)

a. Jumpers or cable connections between locomotive or units will not be allowed to hang with one end free.

b. Cable connections between units and all jumpers will be cleaned, inspected, and tested as often as conditions require to maintain them in a safe and suitable condition for service, but not less frequently than once each three months. Each jumper carrying current having a potential of 600 volts or more will be tested by immersing the cable portion in water and subjecting each conductor with another and with the water, to a difference in potential of not less than $1\frac{3}{4}$ times the normal working voltage and for not less than one minute. Date and place of inspection and test will be stenciled legibly on the jumper or stamped on a metal tag attached securely to jumper.

c. Cable connections between units and jumpers with any of the following defects will not be continued in service: broken or badly chafed insulation; broken or defective plugs, receptacles or terminals; broken or protruding strands of wire; jumpers of improper length.

103. Motors and Generators (Rule No. 144)

Motors and generators will be fastened securely in place. Axle collars will be maintained tight on the axle. Axle bearing and armature bearing caps will be bolted securely in place. Motors or generators with any of the following defects will not be continued in service: broken and loose or excessively worn bearings; excessive sparking or flashing over at commutator; defective collector ring, brush holder, yoke or insulator; loose or broken armature coil bands or wedges.

104. Transformers (Rule No. 145)

Transformers will be fastened securely in place. Liquid filled transformers and related piping will be maintained free from leaks and the liquid maintained at proper level in transformer cases.

105. Rheostats and Grid Resistors (Rule No. 146)

All rheostats and grid resistors will be maintained free from accumulations of dirt or extraneous matter.

106. Voltmeters and Ammeters (Rule No. 147)

All voltmeters and ammeters on units receiving power from an outside source will be tested whenever any irregularity is reported, but not less frequently than once every 6 months. Voltmeters and ammeters on units driven from power generated within the unit will be tested whenever any irregularity is reported but not less frequently than once every 12 months. Meters reading more than 5 percent in error will be corrected.

107. Insulation Dielectric Test (Rule No. 148)

An insulation dielectric test of not less than 1-minute duration will be applied not less than once every year to all circuits and parts carrying current with potential of more than 150 volts. The voltage applied to circuits other than motor or generator windings will be not less than 75 percent above the normal working voltage; the voltage applied to windings will be not less than 50 percent above the normal working voltage. A careful examination will be made of any weakness indicated and all defects remedied before the locomotive is put into use.

108. Insulation Inspection (Rule No. 149)

A careful inspection of all visible insulation and electrical connections will be made not less than once every month and all defects repaired.

Section VI. INTERNAL COMBUSTION EQUIPMENT

109. Fuel Tanks and Piping (Rule No. 150)

a. Fuel tanks and related piping will be maintained free from leaks.

b. When fuel is fed from tank by gravity or pressure, a safe cut-out valve will be provided in the fuel line adjacent to the supply tank which will close automatically when tripped and which can be operated by hand from inside and outside of the cab.

110. Filling and Venting (Rule No. 151)

a. Fuel reservoirs will be arranged so they can be filled and vented only from outside of the cab or other compartments. Vent pipes will not discharge on the roof nor on or between the rails.

b. A gauge which will indicate properly the level of fuel in fuel reservoirs will be provided for each reservoir, or series of reservoirs connected and filled

from a common source; gauges will be located so that they are visible to the person filling the reservoir or reservoirs.

111. Grounding Fuel Tanks (Rule No. 152)

Fuel tanks and related piping will be grounded electrically.

112. Exhaust Gases (Rule No. 153)

a. Exhaust gases will be released entirely outside of cab or other compartments.

b. Pipes carrying hot gases and exposed moving parts of mechanism liable to cause personal injury

will be isolated or guarded against personal contact.

c. Set screws or keys will not protrude from unguarded moving parts of mechanism.

113. Starting Device (Rule No. 154)

Internal combustion engines of more than 5 horsepower will be provided with a starting device that will eliminate the necessity for cranking the engine by hand.

114. Safety Hangers (Rule No. 155)

Suitable safety hangers will be provided for drive shafts.

Section VII. BOILERS

Note. Boilers used in connection with locomotive other than those propelled by steam power.

115. Safe Working Pressure (Rule No. 156)

The safe working pressure of each boiler will be fixed by the chief of transportation, zone of interior, or the railway grand division headquarters, theater of operations, or by a competent mechanical engineer under their supervision, after full consideration has been given to the general design, workmanship, age and condition of the boiler. The minimum factor of safety will be 4.

116. Stresses on Staybolts and Braces (Rule No. 157)

The maximum allowable stress per square inch of net cross-sectional area will be 7,500 pounds for staybolts and 9,000 pounds for round, rectangular, and gusset braces.

117. Strength of Materials (Rule No. 158)

a. When the tensile strength of steel or wrought iron is not known, it will be taken as 50,000 pounds for steel and 45,000 pounds for wrought iron.

b. The maximum strength of rivets per square inch of cross-sectional area will be taken as follows:

	<i>Pounds</i>
Iron rivets in single shear.....	38,000
Iron rivets in double shear.....	76,000
Steel rivets in single shear.....	44,000
Steel rivets in double shear.....	88,000

c. When the strength of material has been determined by tests duly authenticated and shown on the specification card or alteration report, such value may be used when calculating the safe working pressure.

d. The maximum allowable working pressure on

cast-iron boilers will not exceed 15 pounds per square inch.

118. Boiler Number and Badge Plate (Rule No. 159)

a. The builder's name and number, if known, will be stamped on the boiler and will be shown also on the specification card. If the builder's name and number are not known and cannot be obtained, the initials of the Government (U.S.A.) and an assigned number will be used. The name and number once given on the specification card will not be changed thereafter.

b. A metal badge plate showing the name and boiler number and safe working pressure will be attached to each boiler. The badge plate on each steam boiler will be provided with a line indicating the lowest permissible water level and will be attached to the boiler adjacent to the water glass. The badge plate on each hot-water boiler will be attached to the boiler adjacent to the firing opening. If boiler is lagged, the lagging and jacket will be cut away so that plate can be seen.

119. Interior Inspection (Rule No. 160)

Whenever a sufficient number of tubes are cut, the interior of the boiler will be inspected as thoroughly as construction will permit.

120. Removal of Tubes (Rule No. 161)

All fire tubes of boilers in service will be removed at least once every 4 years. After the tubes are taken out, the inside of the boiler will be cleaned and inspected as thoroughly as construction will permit. The boiler will be examined for cracks, pitting, grooving, or indications of overheating, and for damage where mud has collected or heavy scale formed.

It will be ascertained that braces and stays are taut, that pins are secured properly in place, and that each is in condition to support its proportion of the load.

121. Cracks (Rule No. 162)

Any boiler developing a crack in shell sheets will be removed from service until proper repairs are made. A report on WD AGO Form 55-227 (see ch. 12) showing the defects and the repairs made, will be forwarded to the zone transportation officer, Attention: the zone master mechanic, zone of interior, or the railway grand division headquarters, theater of operations, within 30 days after completion of the repair.

122. Fusible Plugs (Rule No. 163)

a. If boiler is equipped with fusible plugs, they will be filled with tin not less than 99 percent pure and containing not more than $\frac{1}{10}$ of 1 percent of lead nor more than $\frac{1}{10}$ of 1 percent of zinc. Fusible plugs will be removed and refilled at least once every year, and such action will be shown on the report of inspection, WD AGO Form 55-227.

b. If boiler is equipped with a low-water alarm using fusible metal which comes in contact with water, steam, or products of combustion, fusible plug will be removed and cleaned at least once every 3 months, and the removal shown on the report of inspection, WD AGO Form 55-227. If other type of low-water alarm is used, it will be inspected and tested at least once every 3 months, and its condition shown on the report of inspection, WD AGO Form 55-227.

123. Exterior Boiler Inspection (Rule No. 164)

The exterior of every boiler will be inspected thoroughly before it is put into service, and whenever the jacket and lagging, or casing, are removed. The jacket and lagging will be removed at least once every 5 years from internally fired boilers, and from pressure parts of other boilers, and a thorough inspection made of the entire exterior of the boiler while under hydrostatic pressure. The jacket and lagging also will be removed whenever a competent officer considers it desirable or necessary.

124. Hydrostatic Test (Rule No. 165)

a. Every boiler before being put into service, and at least once every 12 months thereafter, will be subjected to a hydrostatic pressure of 25 percent above the working pressure. Before the hydrostatic test is applied, the safety valves or water relief valves will be removed and the holes capped or plugged, or means provided for holding valves closed without compressing the spring.

b. After the hydrostatic test is made, all handhole plates and washout plugs will be removed and as thorough an interior examination made as construction will permit. Water-tube boilers will be examined with special care for blistered tubes, tubes out of proper alignment, and for leakage or corrosion. Threaded and flanged joints, steam pipes, and blow-off lines will be examined carefully for corrosion or wasting away. When all necessary repairs are completed, the boiler will be fired up, the steam pressure raised to not less than the allowed working pressure, and the boiler and appurtenances examined carefully. All cocks, valves, seams, studs, bolts, and rivets must be tight under this pressure.

125. Test of Rigid and Hollow Staybolts (Rule No. 166)

a. All rigid staybolts will be hammer tested at least once every 6 months and whenever the hydrostatic test is applied, except that staybolts which have telltale holes $\frac{3}{16}$ inch in diameter extending their entire length need not be hammer tested.

b. The inspector will tap each bolt and determine the broken bolts from the sound or vibration of the sheet. If staybolt tests are made when the boiler is filled with water, there will be not less than 50 pounds pressure on the boiler.

126. Staybolts with Caps (Rule No. 167)

a. Except as provided elsewhere all staybolts having caps over the outer ends will have the caps removed at least once every 2 years and the bolts and sleeves examined for breakage.

b. Certain types of flexible staybolts with which any boiler is equipped are provided with a telltale hole of not less than $\frac{3}{16}$ inch nor more than $\frac{7}{32}$ inch in diameter. This hole extends the entire length of the bolt and into the head not less than $\frac{1}{3}$ of its diameter and is protected by copper plating from becoming closed by corrosion. It is opened and tested by means of an approved electrical or other instrument each time the hydrostatic test is applied. It will not be necessary to remove the caps when such tests positively indicate that the telltale holes are open their entire length. When this test is completed, the hydrostatic test will be applied and all staybolts which show leakage through the telltale hole will be removed.

c. The removal of flexible staybolt caps and other tests will be reported on the report of inspection WD AGO Form 55-227 (see ch. 12), and a proper record kept of the inspections and tests.

d. Fire box sheets not covered by brick work will be examined carefully at least once each month for

mud burn, bulging, and indication of broken staybolts.

e. Staybolt caps will be removed or any of the above tests made whenever the chief of transportation, zone of interior, or the railway grand division headquarters, theater of operations, considers it desirable in order to determine the condition of staybolts or staybolt sleeves.

127. Flexible Staybolts without Caps (Rule No. 168)

Flexible staybolts which do not have caps will be tested the same as rigid staybolts. Each time a hydrostatic test is applied, such staybolt test will be made while the boiler is under hydrostatic pressure of not less than the allowed working pressure, and proper notation of such test will be made on the report of inspection, WD AGO Form 55-227.

128. Broken Staybolts (Rule No. 169)

No boiler will be allowed to remain in service when there are two adjacent staybolts broken or telltale holes plugged, nor when three or more are broken or plugged in the entire boiler.

129. Telltale Holes (Rule No. 170)

All staybolts shorter than 8 inches, except flexible bolts, will have telltale holes $\frac{3}{16}$ inch in diameter and not less than $1\frac{1}{4}$ inches deep in the outer end. These holes will be kept open at all times.

130. Pressure Gauge (Rule No. 171)

a. Each boiler will have a gauge which will indicate correctly the working pressure. Pressure gauge will be graduated to not less than $1\frac{1}{2}$ times the allowed working pressure of the boiler. Gauges will be located so that they will be kept reasonably cool and can be read conveniently.

b. Pressure gauges will be tested at time of quarterly boiler inspection and whenever any irregularity is reported.

c. Pressure gauges will be compared with an accurate deadweight tester or test gauge constructed for the purpose of testing gauges. Other than at times of application of hydrostatic tests pressure gauges used in hot water boilers may be tested in conjunction with the test of water relief valves by comparison under air pressure, with an accurate test gauge. Gauges found inaccurate will be corrected before being put into use.

d. Each pressure gauge used on steam boilers will have a siphon of ample capacity to prevent steam from entering the gauge. The pipe connection will enter the boiler direct and will be maintained steam tight between boiler and gauge. Each time the gauge

is tested, the siphon pipe will be removed and the pipe and its connections examined to see that they are open. Pressure gauges used on hot water boilers may be mounted on the expansion tank, provided no valves are interposed between the expansion tank and boiler.

131. Safety Valves (Rule No. 172)

a. Every steam boiler will be equipped with at least two safety valves and every hot water boiler will be equipped with at least one water relief valve, the capacity of which is sufficient to prevent, under any conditions of service, an accumulation of pressure of more than 5 pounds above the allowed working pressure. The safety valves will be connected with the boiler independent of any other connection and located as closely to the boiler as may be consistent without discharging inside of cab. Water relief valves may be mounted on the expansion tank of hot water boilers provided no valves are interposed between the expansion tank and the boiler. Sufficient clearance to prevent damage will be provided where safety or relief valves or connections pass through cab structure.

b. Safety valves on steam boilers will be set and tested under steam at time of quarterly boiler inspection and also when any irregularity is reported. When safety valves are being set, the water in the boiler will not be above the highest gauge cock. When safety valves or water relief valves are set or tested two gauges will be used, one of which will be located so that it will be in full view of the person setting such valves. Other than at times of application of hydrostatic test, water relief valves on hot water boilers may be tested with air pressure; at times of hydrostatic test they will be tested with hydraulic pressure. Gauges will be tested in all cases immediately before the safety valves or water relief valves are set or tested or any change made in the setting, except that gauges on hot water boilers may be tested with air pressure simultaneously with the test of relief valves at times other than when the hydrostatic test is made. If the indicated pressure of the test gauge and the gauge on boiler vary more than 3 pounds, they will be removed from the boiler, tested, and corrected before the safety valves or water relief valves are set.

132. Water Glass and Gauge Cocks (Rule No. 173)

a. Every steam boiler will be equipped with at least one water glass, and three gauge cocks which can be opened and closed easily by hand. The lowest gauge cock and the lowest reading of the water glass and the line on the badge plate will correspond and

be not less than 2 inches above the danger line. The danger line will be that at which there will be no danger of overheating any part of the boiler. The danger line for vertical fire tube boilers will be not less than $\frac{1}{2}$ the length of the tube above the lower tube sheet; and for vertical submerged tube boilers, it will be the upper surface of the top tube sheet.

b. All water glasses will be supplied with two valves, one in the upper and one in the lower connection to the boiler, and a drain valve, so constructed and located that the valves can be opened and closed easily by hand.

c. The spindles of all gauge cocks and water glass valves will be removed and cocks and valves cleaned thoroughly each time the boiler is washed.

d. Water glasses will be blown out and gauge cocks tested before each trip.

e. Tubular water glasses and lubricator glasses will be provided with a safe and suitable shield which will permit the glass to be seen easily and prevent the glass from flying in case of breakage.

f. Water glasses and pressure gauges will be illuminated sufficiently to enable accurate readings to be made.

133. Feedwater Appliances (Rule No. 174)

Feedwater appliances and their connections will be kept in good condition, free from leaks and accumulations of scale or other foreign matter, and will be tested before each trip.

134. Water Tubes (Rule No. 175)

The ends of all water tubes will extend through the tube sheet or headers and be properly flared or beaded. If flared, they will extend through sheet or header not less than $\frac{1}{4}$ inch nor more than $\frac{1}{2}$ inch and be flared to an angle of not less than 30° . If beaded, the bead will extend over the sheet not less than $\frac{1}{8}$ inch for the entire circumference of the tube. Water tubes improperly applied, bulged, blistered, leaking, cracked, or tubes with sufficient scale to cause overheating, will not be continued in service.

135. Boiler Washing (Rule No. 176)

a. Boilers will be washed as often as water conditions require. Steam boilers in service will be washed not less frequently than once each month and at the time of quarterly inspection. Hot water boilers in service will be washed not less frequently than once each year. When boilers are washed, all hand-hole plates and wash-out plugs will be removed. If boilers can be washed without removing handhole plates and wash-out plugs, such plates and plugs will be removed immediately after boiler is washed and

as thorough an interior inspection be made as condition will permit. Sediment and scale will be removed from water tubes at wash-out periods.

b. An accurate record of all boiler washouts will be kept in the office of the officer in charge and copy of the last record kept in the boiler compartment. The following information will be given on the day that the boiler is washed: number of boiler; number of locomotive unit on which it is mounted; date of washout; signature of boiler washer or inspector who knows that boiler was washed; statement indicating if spindles of gauge cocks and water-glass valves were removed and cocks and valves cleaned; signature of the inspector or person who removed the spindles and cleaned the cocks and valves.

136. Leaks (Rule No. 177)

a. All valves, joints, studs, and seams will be kept reasonably free from leaks.

b. If a leak develops under the lagging, an examination and proper repairs will be made.

c. When wash-out plugs or boiler studs develop leakage, the pressure will be removed, the threads examined, and proper repairs made.

137. Feedwater Tanks and Strainers (Rule No. 178)

Feedwater tanks will be maintained free from accumulations of scale, or other foreign matter, and suitable screens will be provided for feed pipes.

138. Fuel Tanks and Piping (Rule No. 179)

a. Fuel tanks and related piping will be maintained free from leaks.

b. When fuel is fed from tank by gravity or pressure, a safety cut-out valve will be provided in the fuel line adjacent to the supply tank; this safety valve will be of the type which will close automatically when tripped and which can be operated by hand from inside and outside of cab.

c. Fuel reservoirs will be arranged so that they can be filled and vented only from outside of the cab or other compartments. Vent pipes will not discharge on the roof nor on or between the rails.

139. Feedwater and Fuel Oil Reservoir Testing (Rule No. 180)

All feedwater and fuel oil reservoirs carrying pressure will be inspected and tested in accordance with rule No. 103.

140. Boiler and Reservoir Fastenings (Rule No. 181)

All boilers and reservoirs will be securely fastened in place.

141. Steam Headers (Rule No. 182)

Where two or more boilers are connected to the same steam header, each will have a suitable valve between boiler and header.

142. Oil Burning Fire Boxes (Rule No. 183)

Means will be provided for expelling accumulated gases from the fire box of oil burning boilers before the fire is lighted.

Section VIII. REPORTS**143. Filing Reports (Rule No. 184)**

Responsible personnel will complete and file reports as outlined in chapter 12.

144. Accident Reports (Rule No. 185)

If an accident results from failure from any cause of a locomotive or unit or any of its parts, or from contact with an electrically energized part of an appurtenance of such unit, resulting in serious injury

or death to one or more persons, the unit which operates such locomotive will transmit report of such accident immediately to the railway grand division headquarters in the theater of operations or to the chief of transportation in the zone of interior. This report will give specific information as to the nature of the accident, the place where the accident occurred, and the location where the locomotive or unit may be inspected.

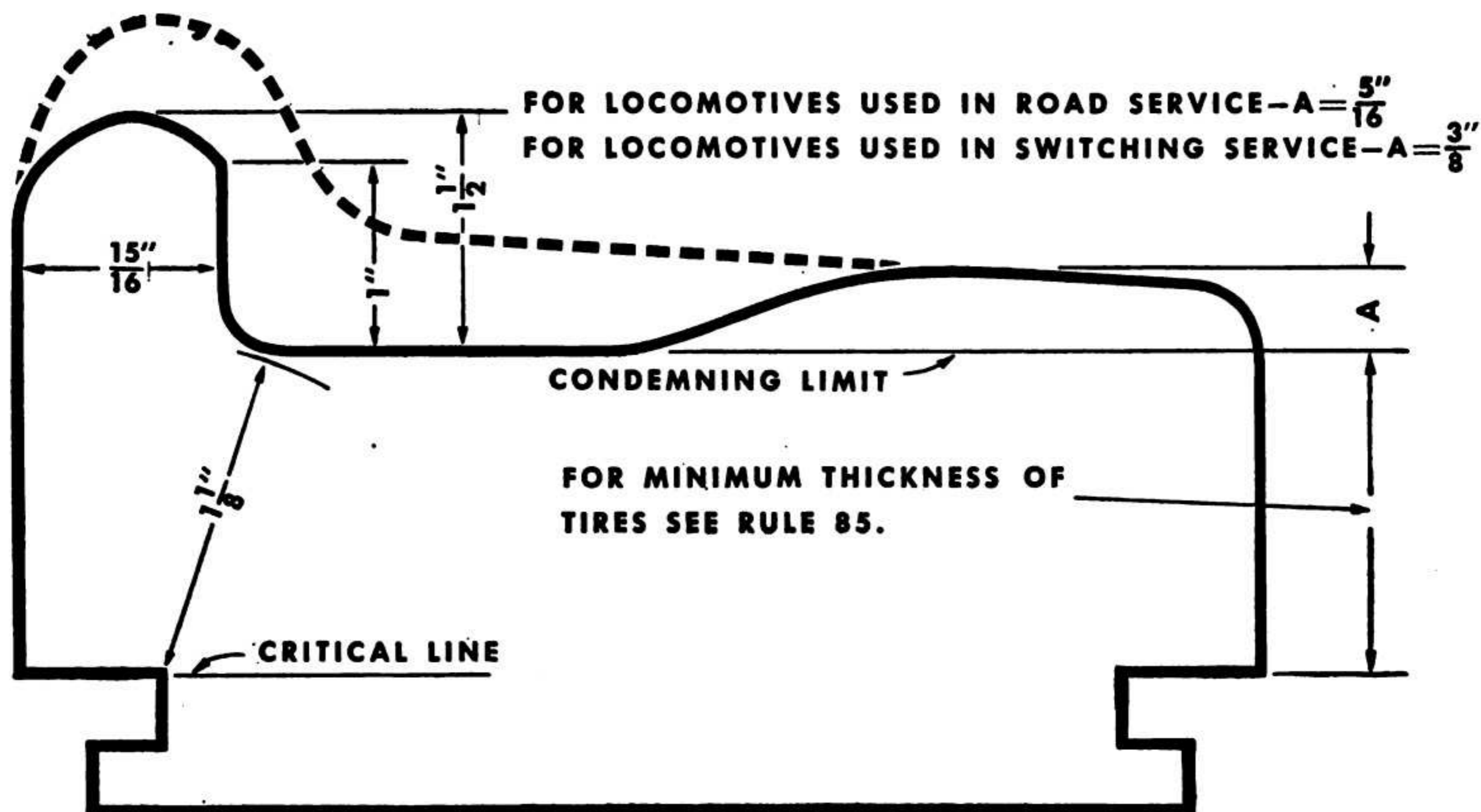


Figure 1. Steel tire retaining ring fastening. Driving and trailing wheels.

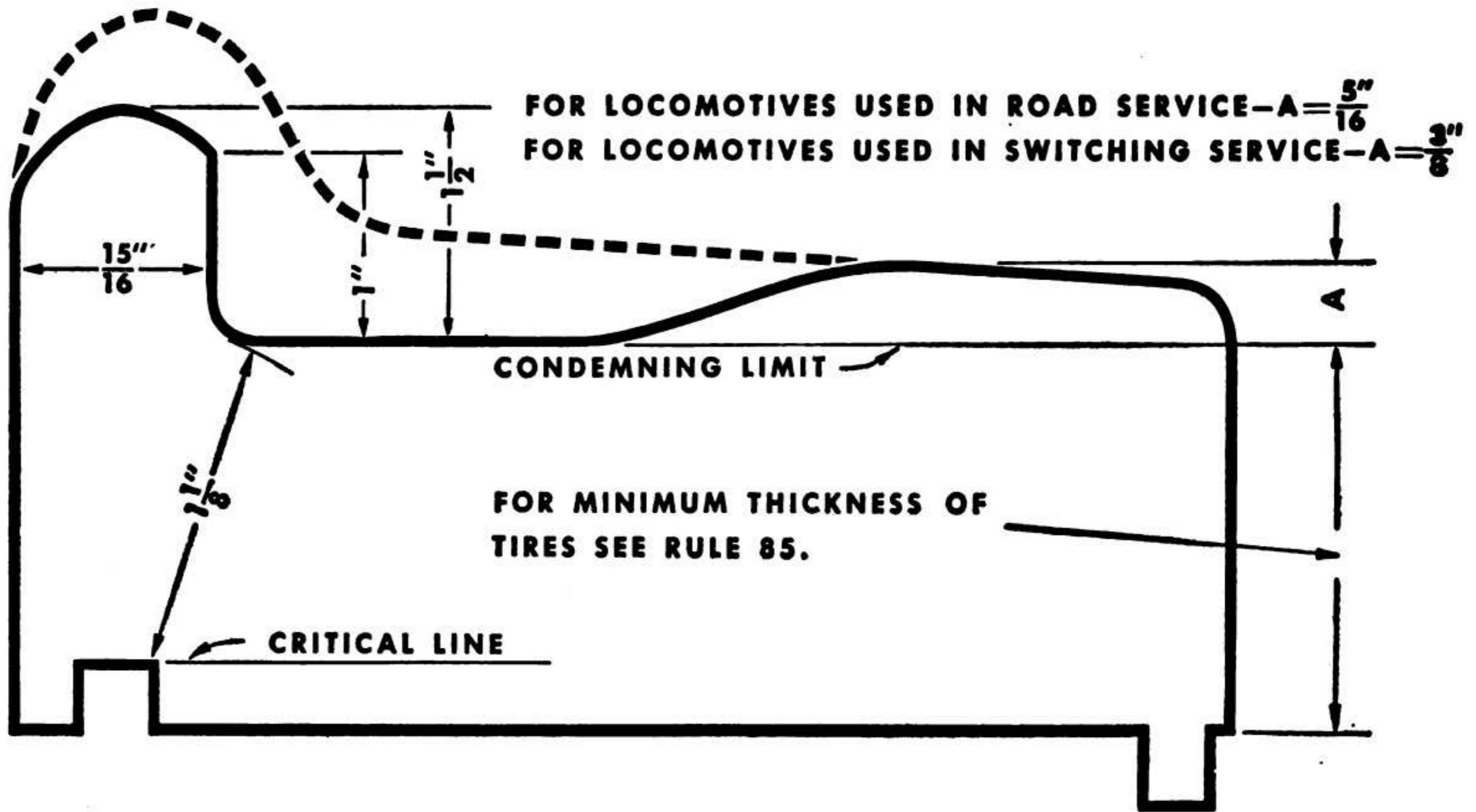


Figure 2. Steel tire shrinkage fastening with shoulder and retaining segments. Driving and trailing wheels.

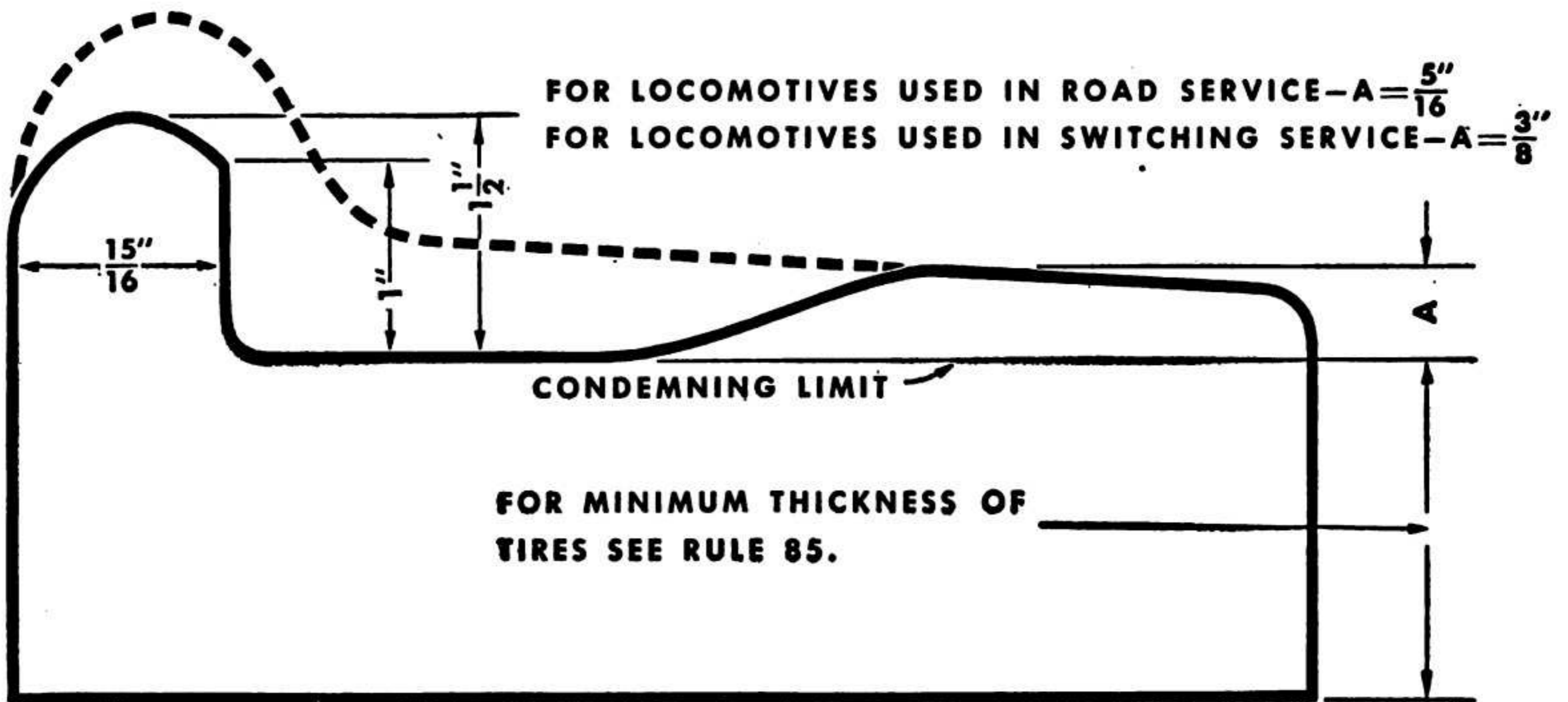


Figure 3. Steel tire shrinkage fastening. Driving and trailing wheels.

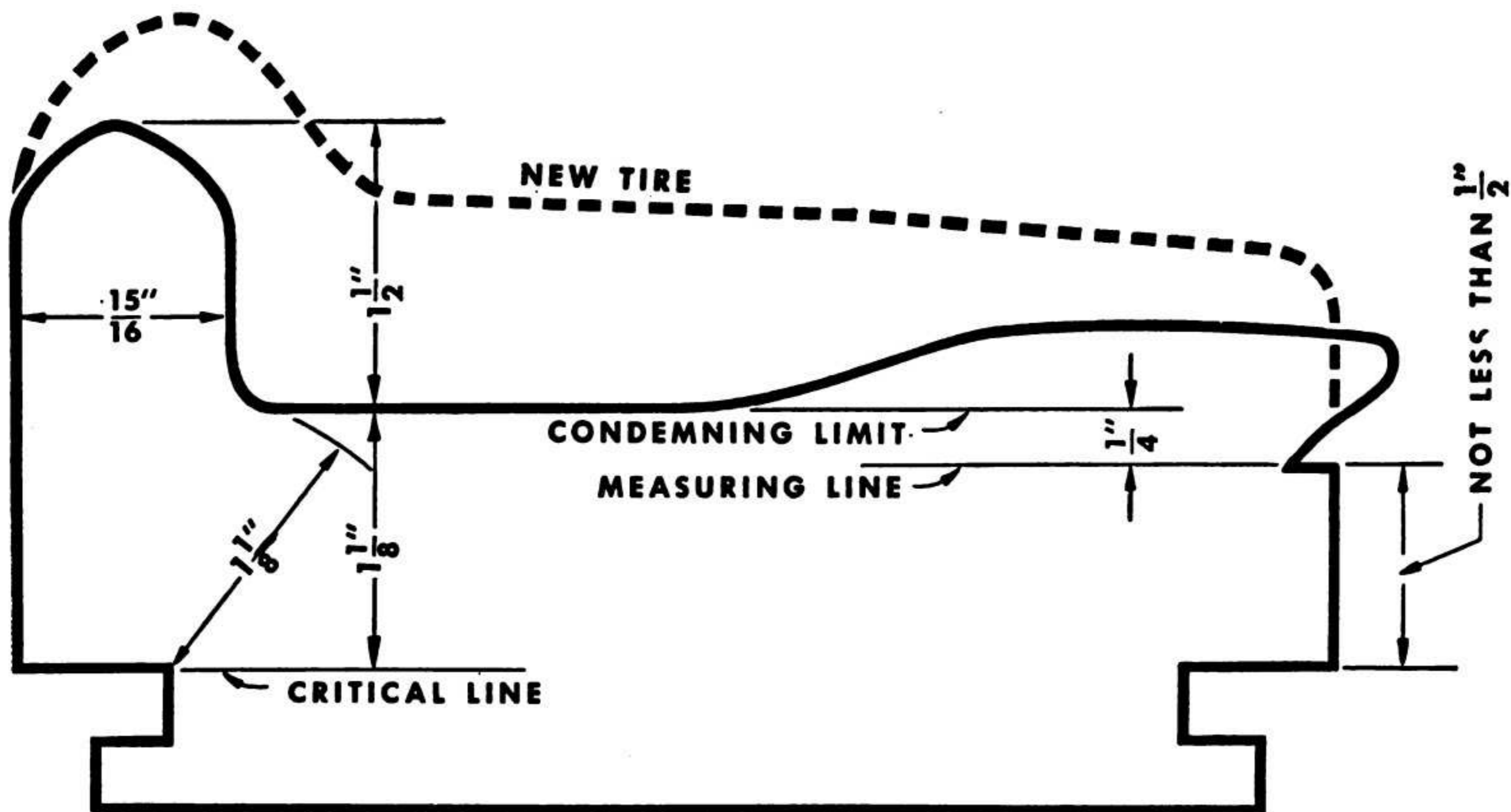


Figure 4. Steel tire retaining ring fastening. Minimum thickness for steel tires. Engine and tender truck wheels. (See Rule No. 80.)

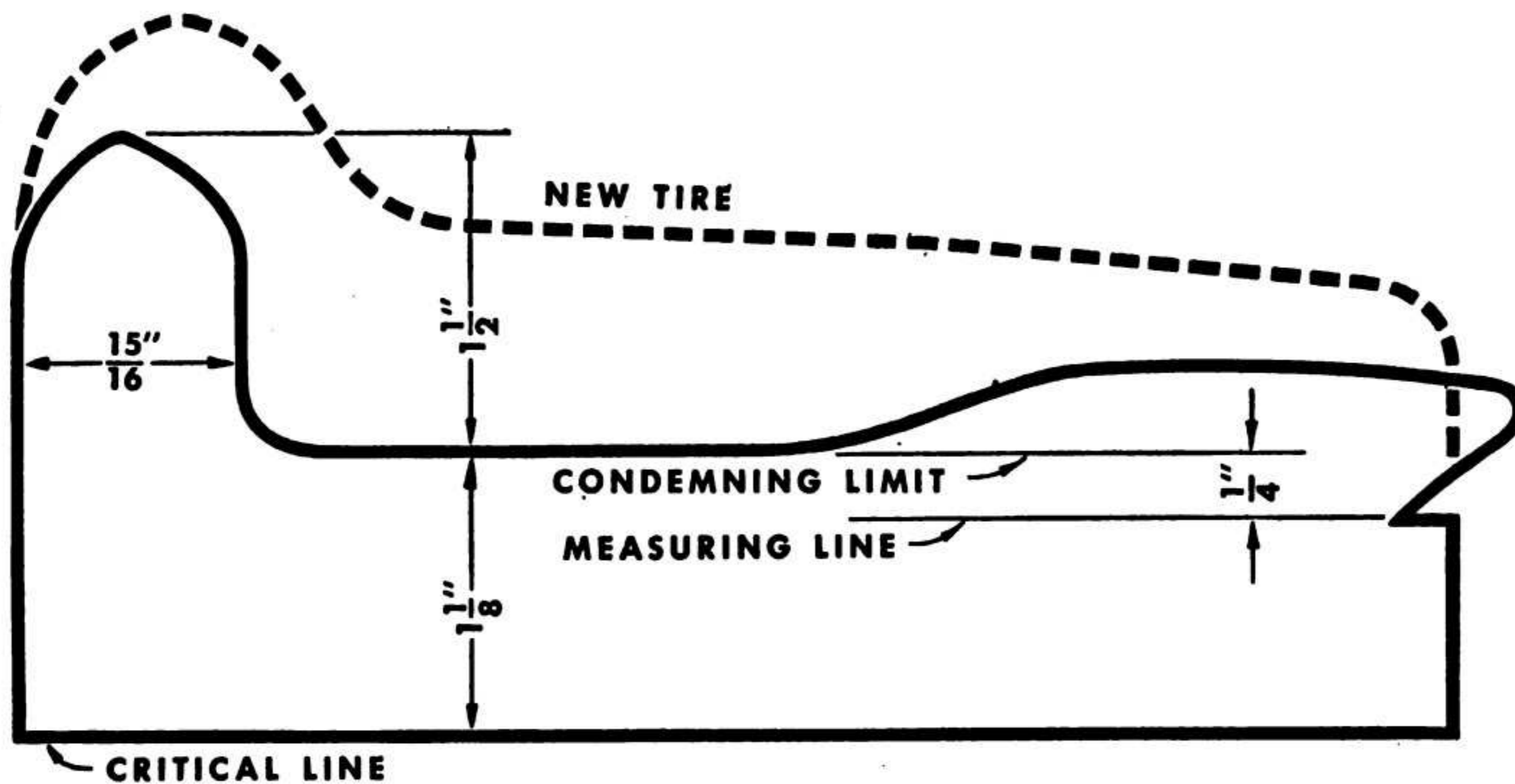


Figure 5. Steel tire shrinkage fastening only. Minimum thickness for steel tires. Engine and tender truck wheels. (See Rule No. 80.)

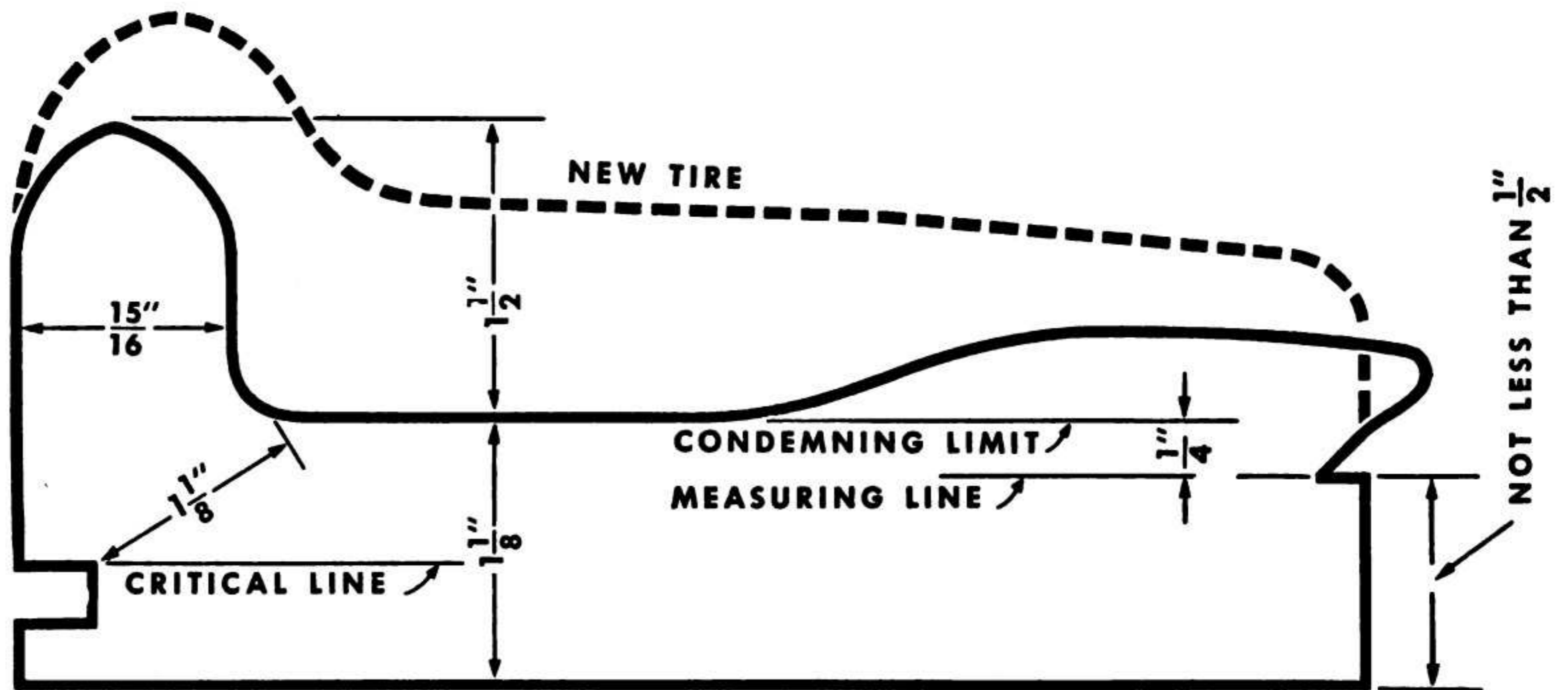


Figure 6. Steel tire retaining ring fastening. Minimum thickness for steel tires. Engine and tender truck wheels. (See Rule No. 80.)

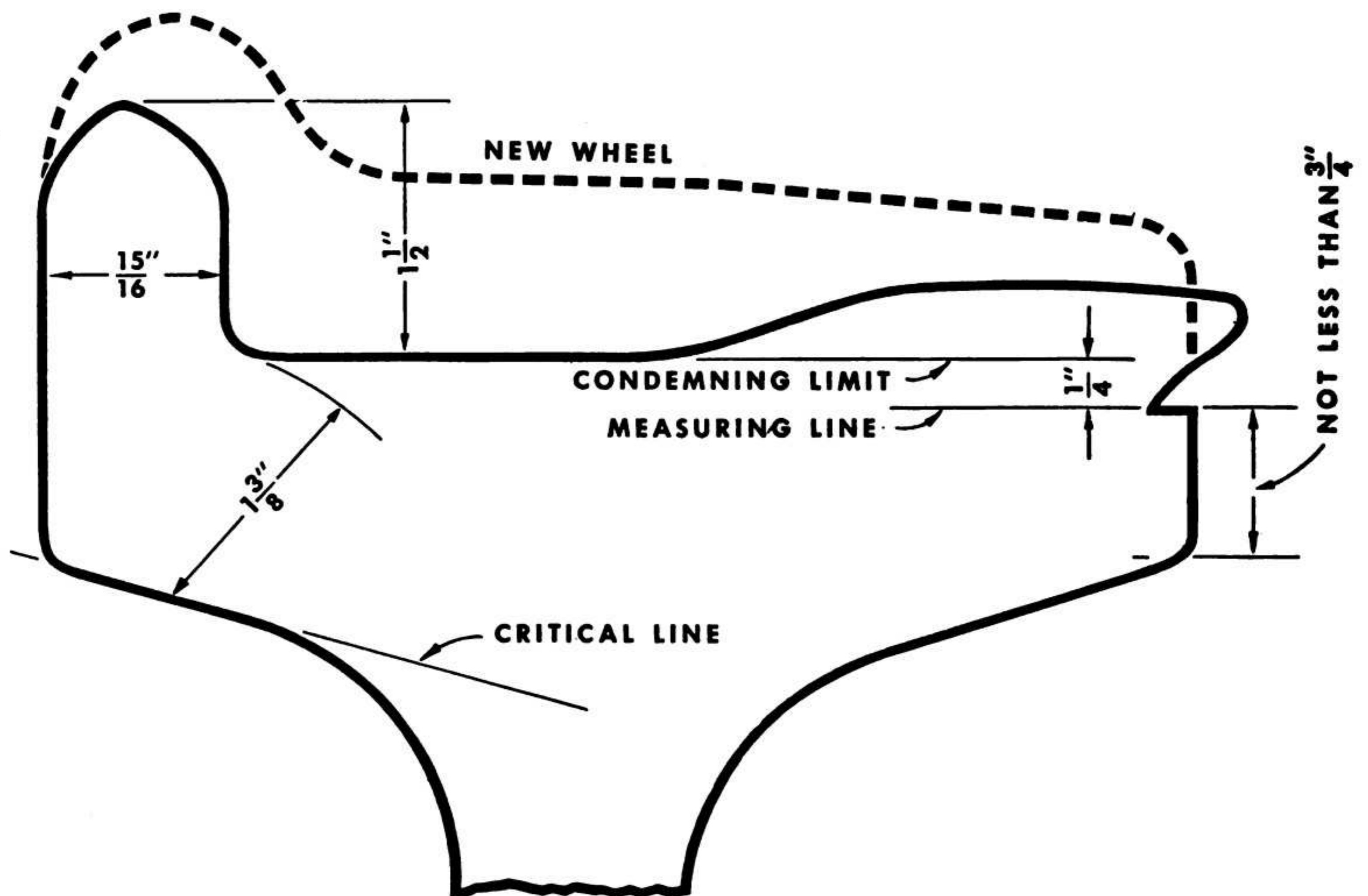


Figure 7. Steel wheel minimum thickness of rim. Engine and tender truck wheels. (See Rule No. 80.)

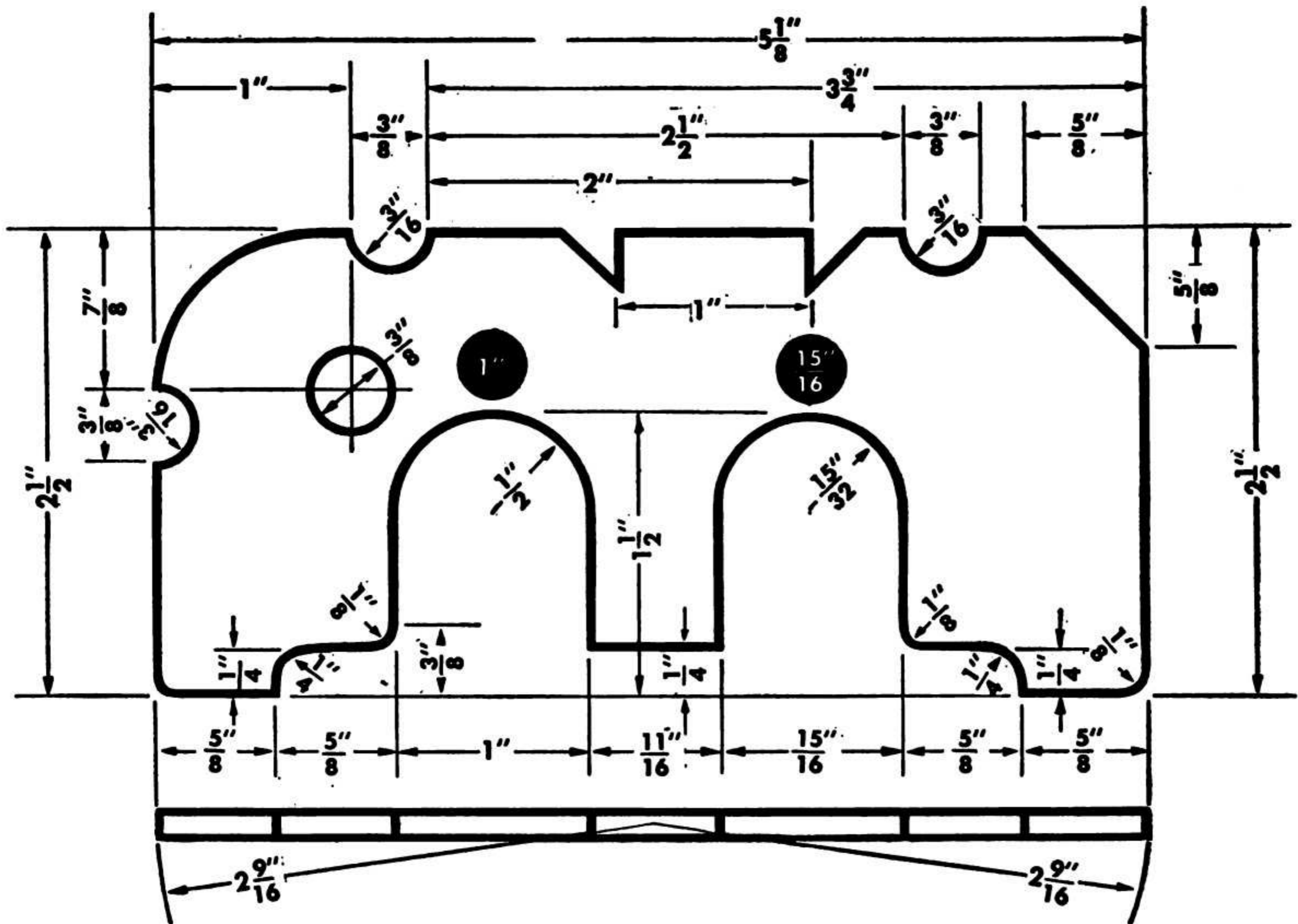


Figure 8. Wheel Defect Gauge (TC Stock No. 41-4012-19-020). This gauge to be used in determining flat spots, worn flanges and broken rims.

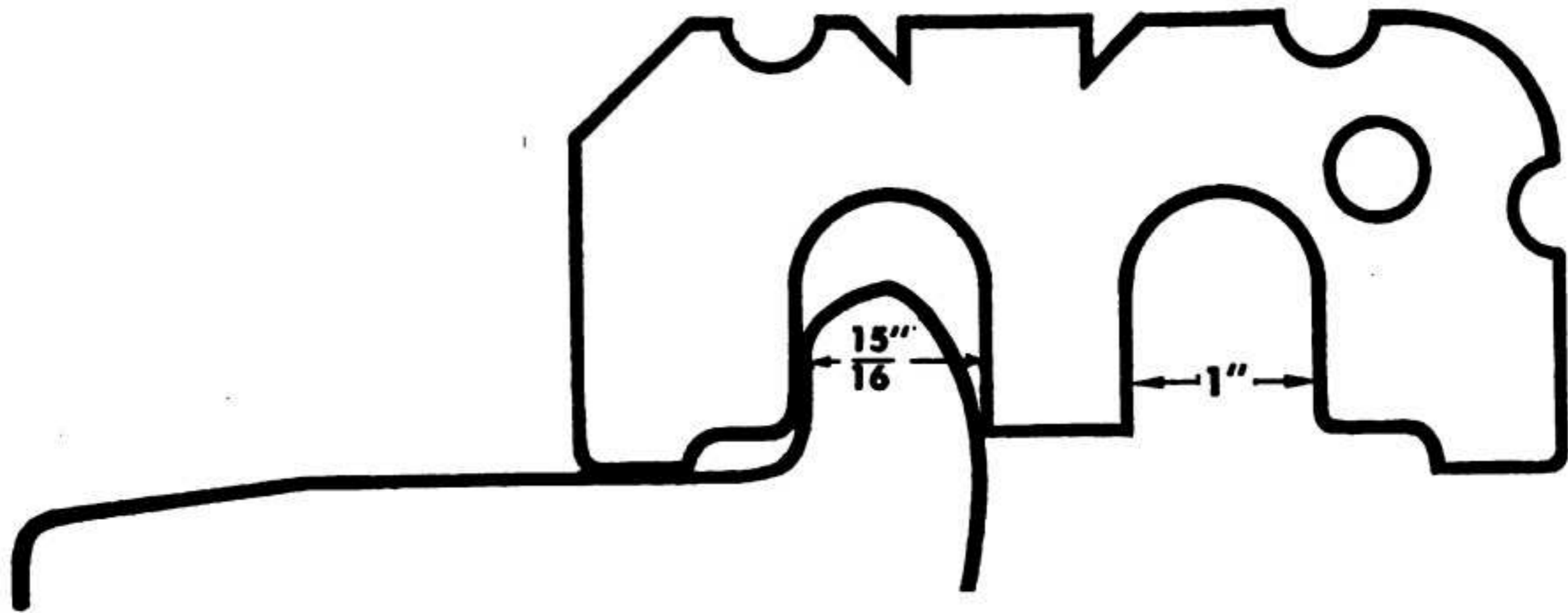


Figure 9. Method of gauging worn flanges.

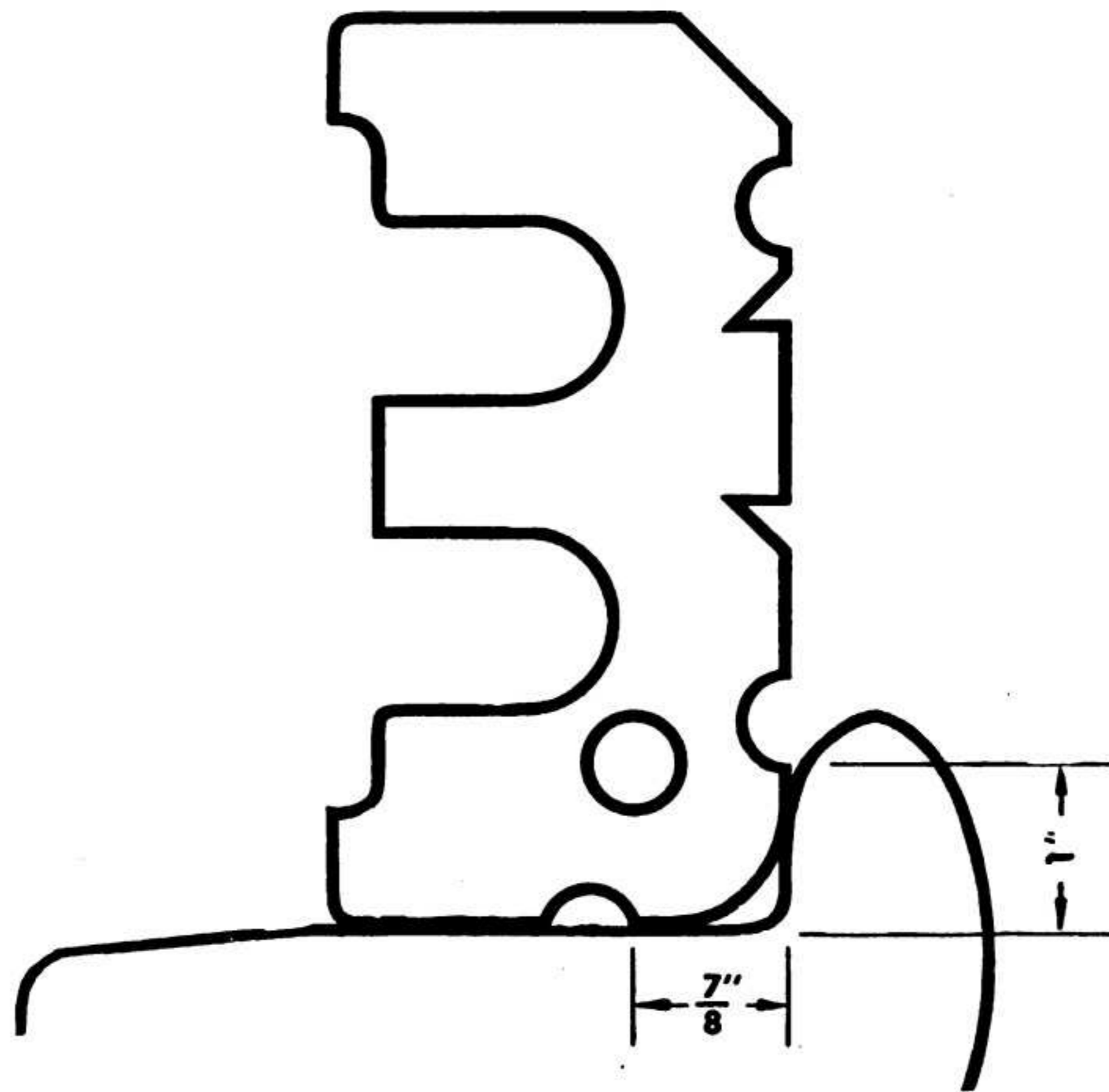


Figure 10. Method of gauging worn flanges.

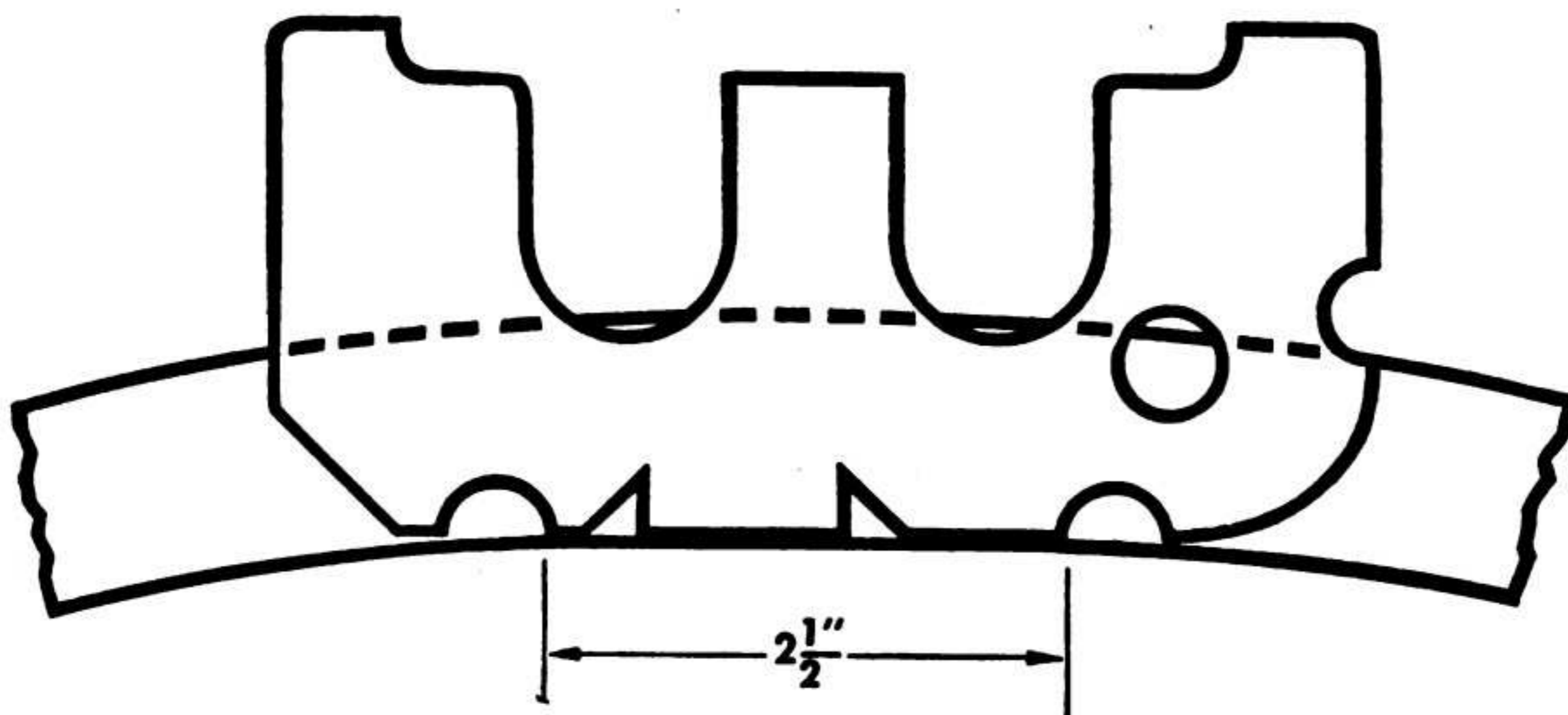


Figure 11. Method of gauging shelled and flat spots.

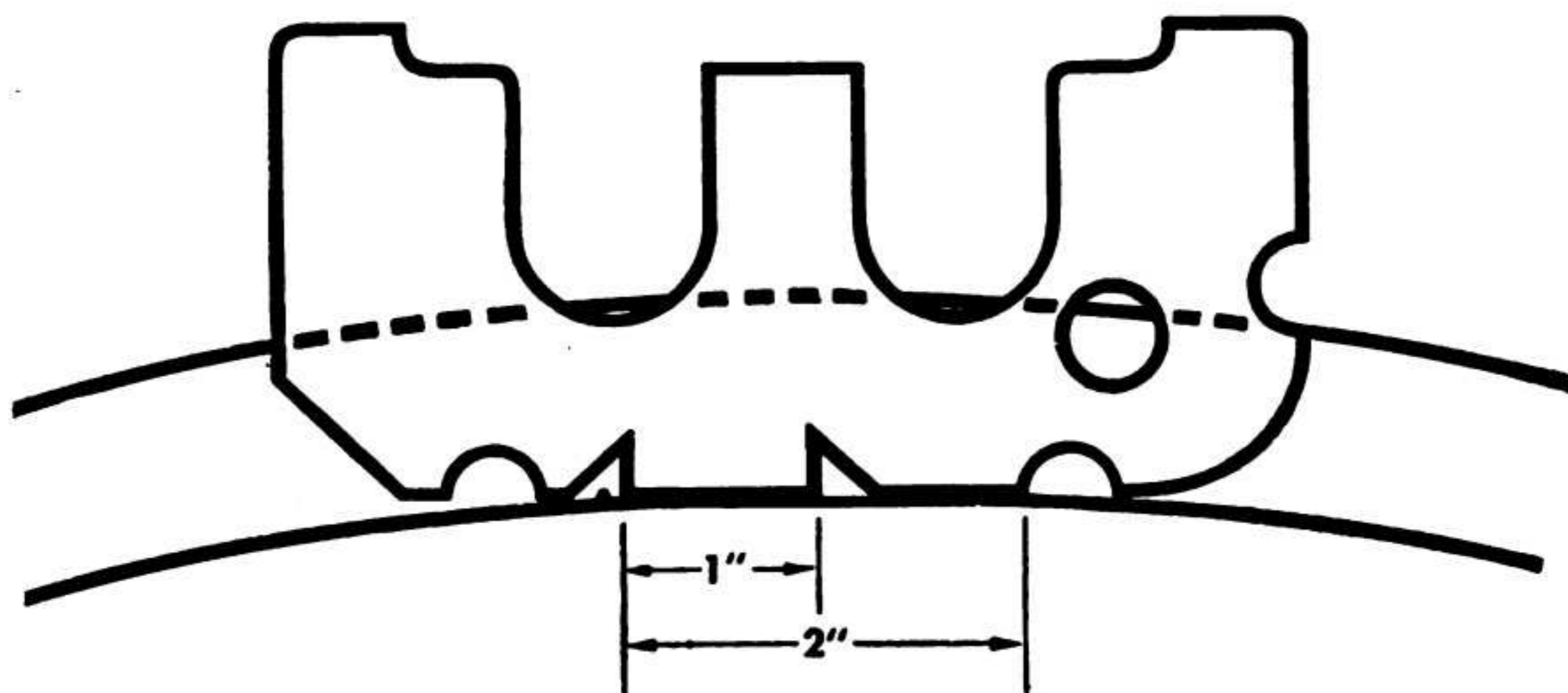


Figure 12. Method of measuring flat spots of 1 and 2 inches.

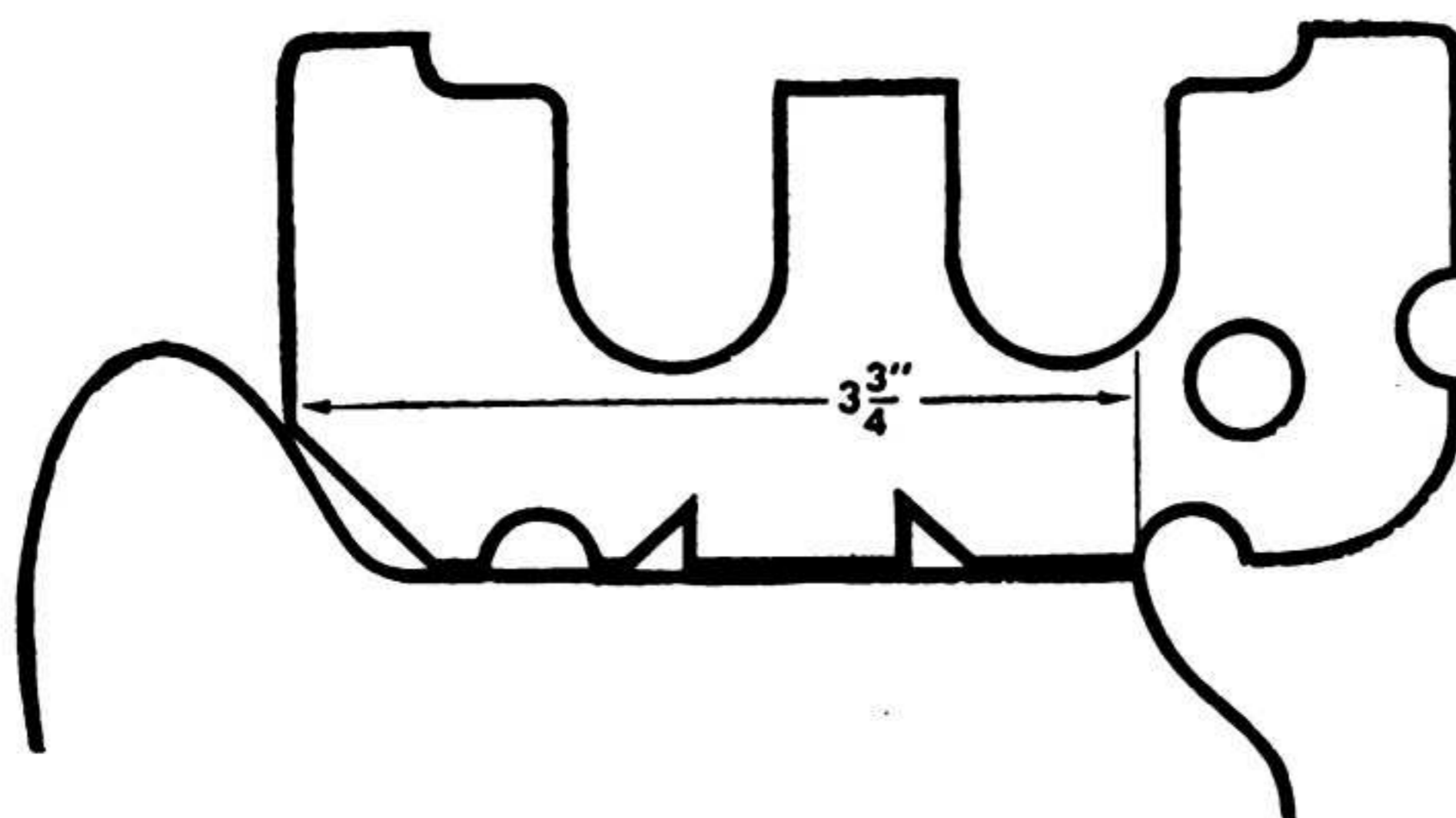


Figure 13. Method of gauging broken rims.

**NOTE:
EDGES OF HOLE TO BE SHARP**

**FOR DIAMETER OF ORIFICES
SEE RULE 49**

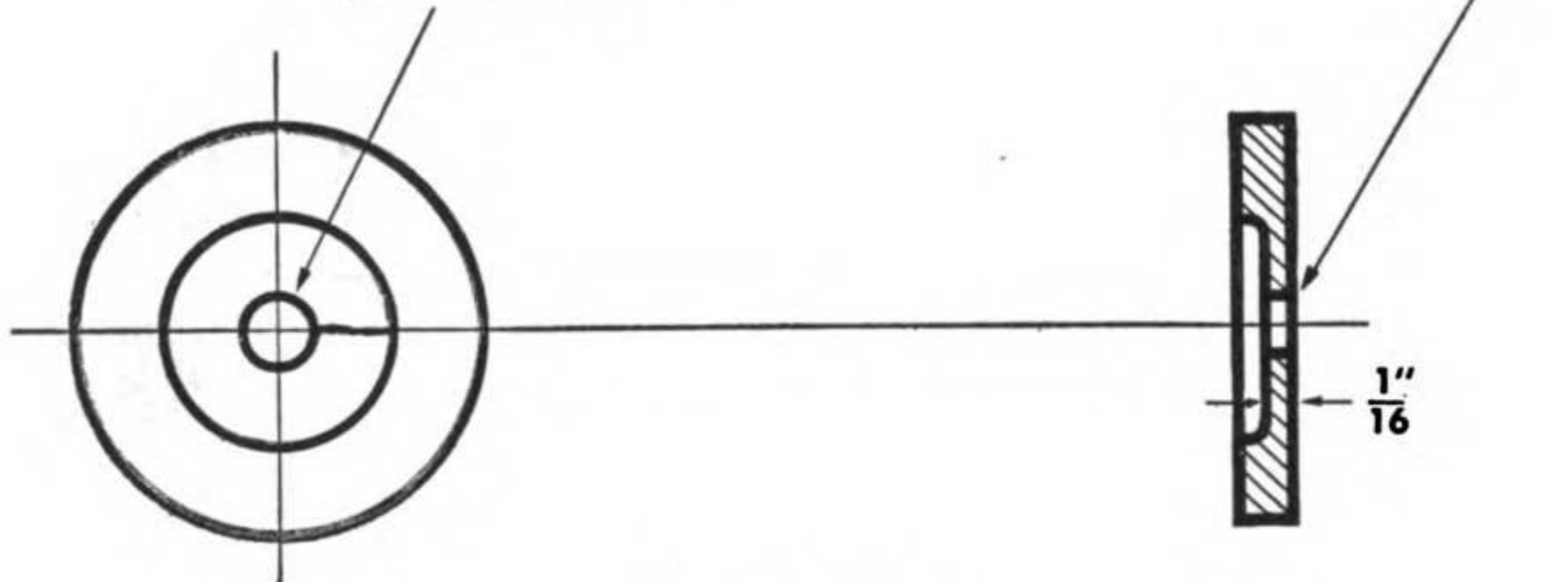


Figure 14. Orifice.

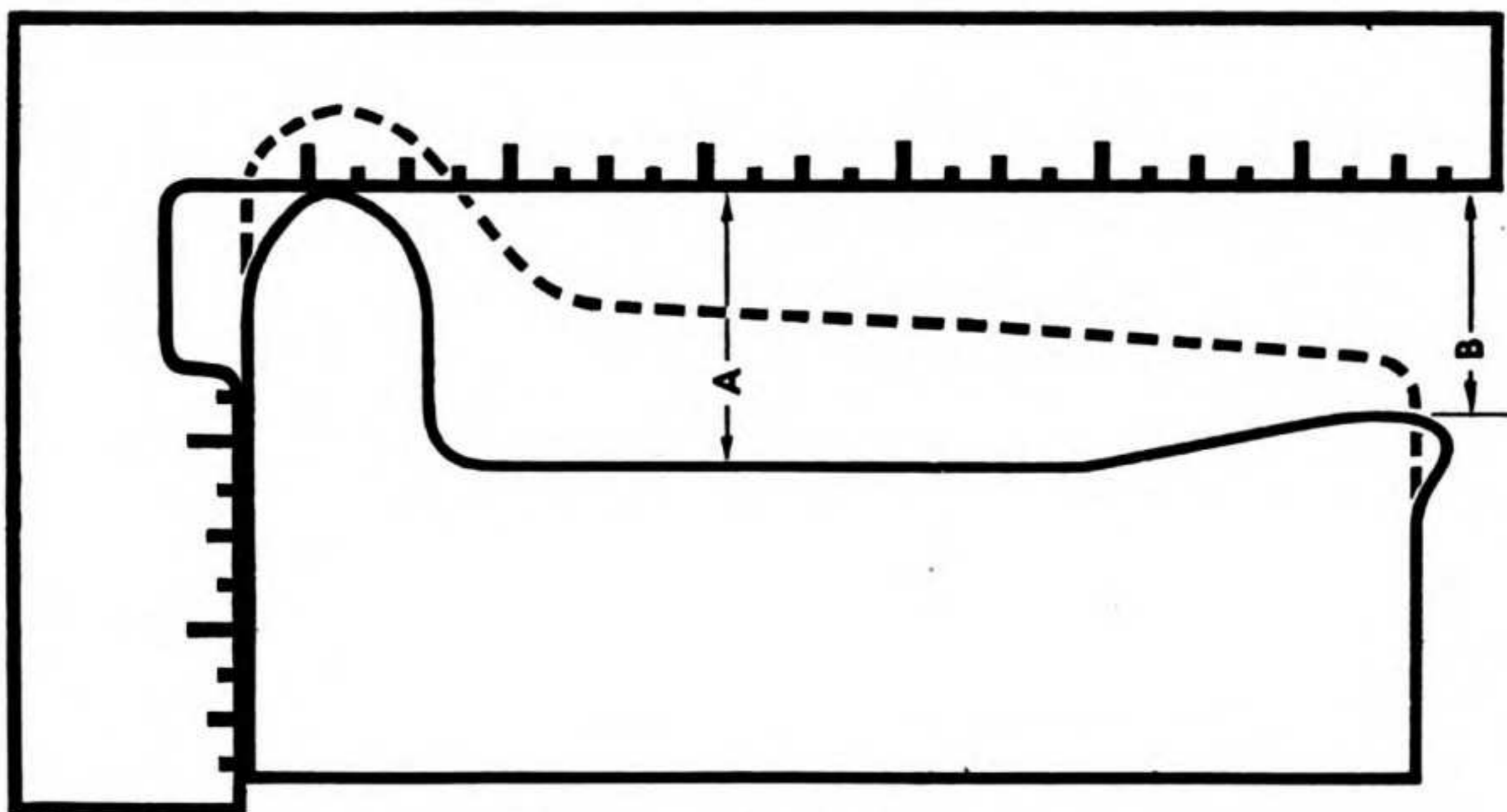


Figure 15. Method of measuring tread worn hollow: Tread worn hollow = A minus B .
Limit: $\frac{1}{8}$ -inch road service, $\frac{3}{8}$ -inch switching service.

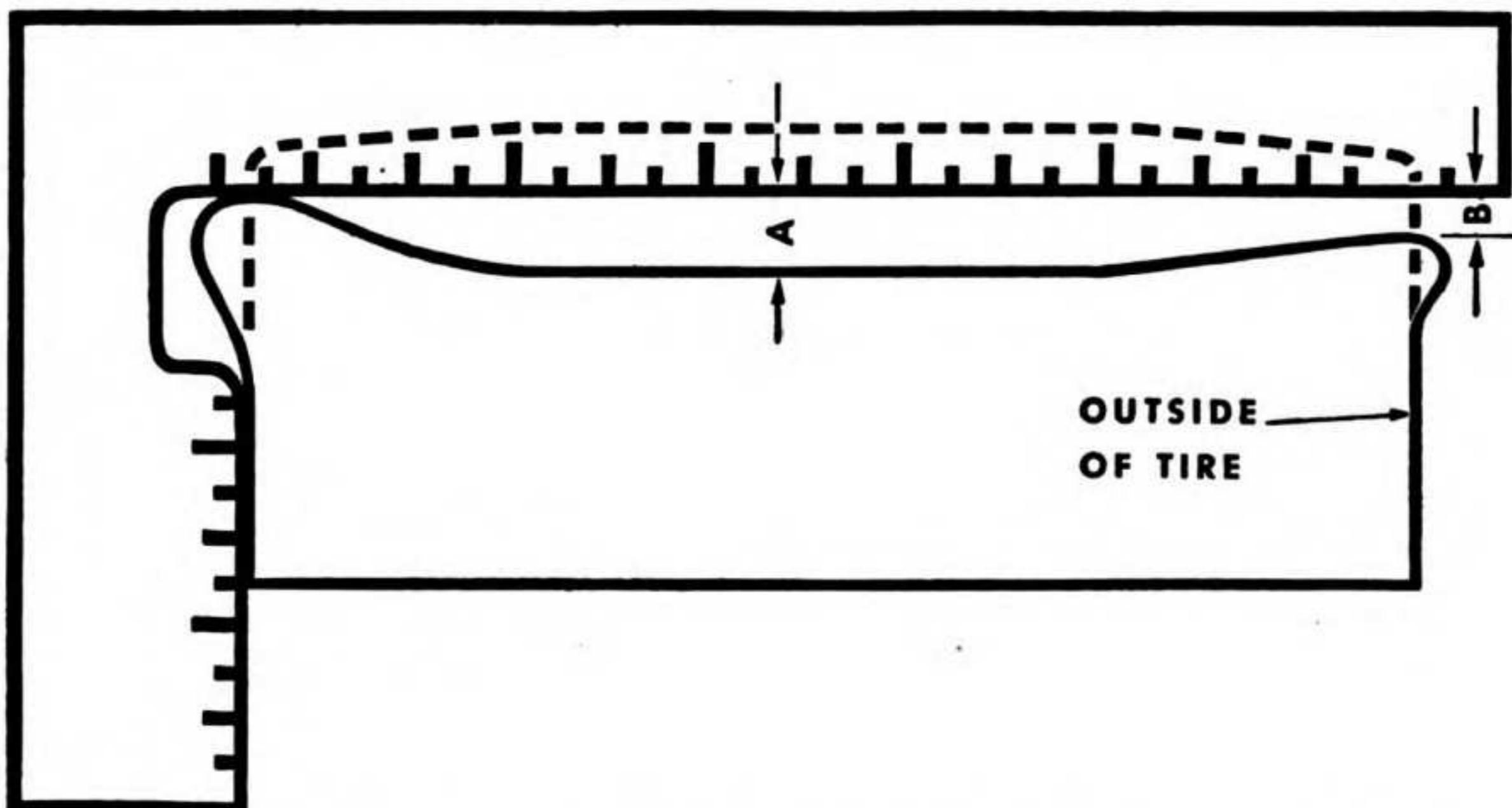


Figure 16. Method of measuring tread worn hollow: Tread worn hollow = A minus B .
Limit: $\frac{5}{16}$ -inch in road service, $\frac{3}{8}$ -inch in switching service.

DIESEL-ELECTRIC LOCOMOTIVES

Section I. GENERAL

145. Diesel Engine

a. The Diesel engine compares with an ordinary automobile engine in that it has a constant torque, constant speed, and is a constant horsepower engine. Since it has no starting torque its use as a prime mover in a railroad motive-power unit must be combined with an electric drive transmission system intermediate between the engine shaft and the locomotive wheels. Thus the Diesel-electric combination achieves the main objective of motive-power which is the acceleration of trains from rest to speed and maintenance of the speed of the train at values depending upon the power limitations of the motive-power unit and the right-of-way on which the train is to be operated.

b. To use the full power output of the engine, this transmission system must be capable of exchanging torque for speed, and vice versa, as the demands of train operation on the motive-power unit require. During starting periods the motive-power must exert high tractive effort at low speeds to speed up the train. When running at speed the tractive effort requirements are quite low until heavy adverse gradients are met. The surmounting of such gradients requires high tractive efforts, and speed is sacrificed to obtain the required pulling power. Unlike the straight electric locomotive which has considerable power supply available from the contact system, the power on the Diesel locomotive is limited to that deliverable by its own engine equipment.

c. Various systems use gear changes and clutches (as in the conventional automobile transmission) or hydraulic torque converters; however, their success has been limited. Because of its tremendous cost and upkeep a non-electrical transmission system is not practical for the large powers necessary in heavy switching and road-locomotive work.

d. Various attempts, none successful, have been made to eliminate the transmission system. For ex-

ample, the Diesel engine was connected direct to the driving wheels (as is the case with the conventional steam locomotive) and was operated as a variable speed engine between a low limit, corresponding to minimum firing speed, and a top limit, as set by mechanical considerations. In this instance, some auxiliary means such as steam or compressed air in the cylinders of the Diesel engine was used to furnish the required starting torque and running torque up to the speed at which the engine would fire as a Diesel engine.

e. The Diesel-electric locomotive is less affected by climatic conditions than is the steam locomotive. Severe snow conditions and sub-zero temperatures are less likely to interfere with Diesel-electric operation. Low temperatures retard steaming performance in the steam locomotive but benefit the Diesel-electric locomotive by reducing the adverse heating effects of electric equipment.

f. With the exception of a few low-powered switching locomotives and light rail-cars, the electric drive system is employed almost universally for Diesel locomotives.

146. Preliminary Instructions

a. BATTERY. Before attempting to operate or do any work on Diesel-electric locomotives, the operator will observe the following preliminary instructions:

(1) To maintain a satisfactory state of charge in the battery, and to realize good battery life follow carefully the battery builder's instructions and instructions on battery heater when a battery heater is used.

(2) An electric meter on a gauge panel records that the charging generators are functioning and that the battery is being charged.

(3) When the needle of a voltmeter is in the first long RED band it indicates that the battery is in bad condition or being discharged. When the needle is in the WHITE band it indicates that the battery is

neither being charged or discharged. When the needle is in the GREEN band it indicates that the battery is receiving a normal charge. When the needle is in the small RED band beyond the GREEN it indicates that the battery is being overcharged. The engine crew will report to responsible maintenance personnel when the voltmeter indicates in the RED band of the dial. *Note.* The pointer may be in the WHITE band just below the GREEN band for a short time after the engines are first started.

(4) An ammeter, when used, also indicates the condition of the battery. Generally the amount of current shown on the charging portion of the dial is proportional to the state of charge of the battery. As the pointer approaches zero the battery gets nearer to fully charged condition. When the pointer is in the discharge portion of the dial the battery is delivering instead of receiving current. When this condition exists under normal operation it will be reported promptly to maintenance personnel. Neither the voltmeter nor the ammeter will show the condition of the battery unless the charging voltage for normal operation is at such value as to maintain the battery at proper charge.

(5) To protect the battery against discharge and short circuits, the locomotive is shipped with the ground connection removed from the battery. This must be restored before putting the locomotive in service.

b. BATTERY SWITCH. (1) This switch disconnects the battery from the circuits and will always be opened when leaving the locomotive for an idle period. It will also be opened whenever work is being done on any of the control circuits.

(2) If necessary to work on any of the circuits or devices not protected by a cut-out switch, the ground will be removed from the battery.

c. CONTROL SWITCHES. To prevent the battery

from discharging, open all switches in the circuits for which the battery supplies current when the locomotive is standing idle.

d. THROTTLE OR CONTROLLER HANDLE. (1) To prevent accidental starting of the locomotive, always leave the throttle or controller handle in a position which will insure that the traction motors disconnect from the generators whenever the engines are started.

(2) Never leave the operating position without first placing the reverser handle in the neutral position. If the reverser handle is the portable type, remove it for further protection.

e. INDICATING LIGHTS. (1) On most Diesel locomotives, indicating lights are located in the center of the gauge panel and between air gauges to show the operator the motor connections.

(2) The green light indicates when the traction motors are in the series connection and the amber light when they are connected in parallel.

(3) Although the transfer from series to parallel and from parallel to series is automatic, care will be taken not to operate the locomotive, except for a few minutes, with the ammeters reading 400 and above with the motors in parallel (amber light). When the locomotive load condition is such that the automatic transfer does not take place within a few minutes after the ammeters have reached 400 amperes, the operator will move the throttle lever toward the off position until the green light is lit after which the throttle lever may again be moved to the full throttle position.

(4) When both lights are on at the same time, it indicates that the transfer has not taken place at the same moment in both circuits. This need not cause any concern unless this condition continues over a period of several minutes in which case a check will be made to determine the cause.

Section II. OPERATION OF LOCOMOTIVE

147. Speed

Do not operate the locomotive at any higher speed than that given on the locomotive data plate. It is important that this speed is never exceeded when the locomotive is operating either on its own power, coasting down grade, or being towed, unless the traction motor pinions are removed.

148. Precautions before Starting Locomotive

Before starting the engines, the operator will:

a. Be thoroughly familiar with instructions con-

tained in the appropriate WD Technical Manual accompanying the equipment.

b. Be sure the engines are properly lubricated and in operating condition.

c. Check position of all manually operated valves for correctness.

d. Check engine fuel oil supply.

e. Check engine cooling water supply.

f. Check lubricating oil supply.

g. Check for anything loose or under repair in the engine compartment.

h. Check for accumulation of water or oil with cylinder test valves or compression release lever.

i. Make sure all fuses are in place.

j. Check air supply in main reservoirs.

k. Make sure that the brakes operate properly and that the air pressure in the reservoir is normal.

149. How Power Is Obtained

a. The engine supplies mechanical power to the generator which is converted to electrical power for the traction motors and auxiliaries. Each engine and its respective generator is at all times electrically, as well as mechanically, an independent power plant unit.

b. The control is so arranged that opening the throttle at the operator's position increases the speed of the engine or engines. This increases the power furnished the generator which in turn furnishes the power for the traction motors. The throttle adjustment will be maintained so that each engine takes its proper share of the load.

150. Starting the Engine

Before operating the power plant, the operator will:

a. Observe all of the foregoing preliminary instructions and the instructions contained in appropriate War Department Technical Manuals issued with the equipment.

b. Close the battery and control switches.

c. Make sure that the reverse handle is in neutral position and the throttle handle in idling position. (In cold weather it may be necessary to advance the throttle beyond the idling position to get the engines started.)

d. Start each engine by pushing the starter button for the respective engines, observing that each engine operates properly and that the lubricating oil pressure builds up.

e. Allow the compressors to pump air until the main reservoir air gauge shows no further increase in pressure. Determine that the compressors function properly. Reduce the engine speed to idling when finished pumping up air.

f. Observe the operation of all belt-drive machines and other equipment to make sure that they function properly.

g. Apply air brakes to make sure that they operate properly.

h. See that the battery is being charged as indicated by the battery meter.

i. If operating in cold weather, use a kerosene heater, when provided, to warm up the engine before starting. To start this heater the operator will—

(1) See that there is sufficient kerosene in the supply tank.

(2) Open the valve in the line between the top of the water heater and the engine water jacket; close this valve when the engine is operating. A thermostat shuts off the water circulation to the radiator.

(3) Light the wick and adjust for a clear blue flame. Readjust the wick, if necessary, after the heater has warmed up.

(4) Wait until the engine temperature shows at least 60° to 70° F. on the engine temperature indicator before attempting to start the engine.

(5) After the engine starts, shut off the heater and close the valve to the engine cooling system.

151. Operation of Locomotive

When the Diesel-electric locomotive is ready to operate in accordance with the foregoing instructions, the engines are operating, and the main reservoir is fully charged, the operator will:

a. Release the hand brake before attempting to start the locomotive.

b. Move the reverser handle to forward or reverse position as desired.

c. Advance the throttle handle:

(1) When the throttle handle is advanced, certain control circuits are energized which close the line contactors and establish connection between the traction motors and generators. Increased current through the traction motors, or acceleration of the locomotive, is obtained by advancing the throttle handle. Change from series to parallel connections of the traction motors is established automatically at the proper point.

(2) In order to change the direction of motion of the locomotive, place the throttle handle in position for idling the engines, bring the locomotive to a stop, shift reverser handle and advance the throttle again. Never reverse the locomotive while it is in motion except in cases of extreme emergency.

d. Sand the rails when there is a tendency for the wheels to slip and close the throttle slightly until the wheels stop slipping. In case the wheels lose their grip entirely and spin, move the throttle into idling position until the wheels take hold.

e. When coming to rest on a grade, apply the brakes on the locomotive before closing the throttle handle. Likewise, when starting on an ascending grade, do not release the brake of the locomotive until the throttle handle has been opened sufficiently to prevent the train, or locomotive, from drifting backward.

f. When, for any reason, the current fails on the

locomotive, close the throttle handle, and, if on a grade, apply the brakes.

152. Precautions while Operating Locomotive

After starting the engine, the operator will:

- a. Make regular checks of lubricating oil pressures and cooling water temperatures.
- b. If, for any reason, the engines become overheated, allow engines to cool off before adding water to the cooling system.
- c. After pulling heavy loads, allow the engines to idle for 10 minutes before stopping them to prevent boiling the cooling water.
- d. Open the adjustable engine-hood hatches during warm weather operation.

153. Brakes

In operating brakes the operator will—

- a. Not depend upon the air brakes to hold the locomotive on a grade when the compressors are shut down.
- b. In emergencies apply the brakes immediately and shut off the power afterwards.
- c. Apply the brakes sooner than on a steam locomotive since an electric locomotive has much less friction and the flywheel effect of the motor armature tends to keep the locomotive moving.

154. Ventilation of Engine Compartment

During the warm weather operation, the adjustable hatch-covers on the engine compartment roof should be raised.

155. Safety

Personnel will not—

- a. Reach inside the frames of generators or motors while they are in operation.
- b. Leave tools or any other loose objects near the electrical equipment when the locomotive is in operation.

156. Operation with One Power Plant Only (Locomotives Equipped with Two Power Units)

- a. A locomotive may be operated at any time with one power plant simply by leaving the other power plant shut down. With only one power plant operating, special care will be taken to avoid pulling heavy loads.
- b. Take proper precautions if there is any danger of the water freezing in the shut-down engine.

157. Operation with Motors Cut-out

In event trouble develops which makes it necessary to cut out a traction motor, shut down the engine

which furnishes power to that motor. Special care will be taken to avoid pulling heavy loads, while traction motor is inoperative.

158. Overheating of Engines

In case the engines become overheated, the operator will—

- a. Let the engines idle for 10 minutes before shutting them down. Never stop the engines immediately after a hard run. Circulation of the cooling water depends upon the circulating pump and when the engines are shut down, the pumps stop also. The iron masses in an engine pulling full load absorb sufficient heat to boil the cooling water if the circulation stops.
- b. If the water supply has failed, wait until cylinders have become normally cool before turning in water.
- c. Watch for overheated heads; heads are liable to crack and be damaged if they become too hot and water is turned into them.

159. Stopping the Engine

To stop the Diesel engine, the operator will—

- a. Move the throttle into the extreme forward position.
- b. Close the throttle valve by hand if it should stick in the "open" position.
- c. If an engine fails to stop under normal conditions or if it over-speeds, close the emergency shut-off cock on the side of the fuel pump.

160. Leaving the Locomotive

Before leaving the locomotive, the operator will—

- a. Shut down the engines.
- b. Place reverser handle in neutral position.
- c. Open all switches.
- d. Close all doors, windows and hatches.
- e. Close radiator shutters.
- f. Release air brakes and set hand brakes; if necessary, block wheels to prevent undesired movement.
- g. If weather is freezing and locomotive cannot be run in the roundhouse, or attached to an outside steam connection, drain water unless anti-freeze is used.

161. Temperature Control of Cooling Water

- a. Diesel engines are provided with a thermostat in the cooling water outlet and have air fans belted directly to the engines. Water is thus shut off from the radiator but permitted to circulate through the engine cylinder block when the temperature of the water in the engine is below that for which the thermostat is set.

b. During cold weather it may be necessary to close the shutters in front of the radiators in order to maintain the proper temperature. If, during extremely cold weather, it becomes difficult to maintain engine temperature at the proper level, the shutters in the side doors also may be partly or entirely closed, especially on the windward side of the locomotive. (For normal operation these shutters will be kept open.)

c. When the engines are shut down during the cold weather, it is advisable to close all shutters. The control levers in the operating cab are marked to show the position of the radiator shutters.

d. If it becomes difficult to operate the shutters, it may be caused by lack of lubrication at the hinge pins of the vanes and at the operating lever pin joints. Lubricate with a light oil.

162. Compressors and Other Auxiliary Machines

The compressors and other auxiliary machines are driven by "V" belts from the generator. Adjustment of the belt-tension is provided by moving these machines on their bases to change the distance between the pulley centers. A fairly accurate guide for determining the correct tension on the belts is to make the adjustment by pressing on each belt with one finger to a depth of 1 inch at a point midway between the pulleys.

163. Battery Charging Equipment

a. In general the function of the auxiliary generators, or charging generators, is to supply the control and the lighting load and to charge the batteries. On locomotives with more than one power plant, the generators are connected in parallel for battery charging.

b. The battery charging equipment for each power plant consists of an auxiliary generator, belt driven from the main generator; a voltage regulator, and a reverse current relay.

164. Engine Starting Equipment

In this type of starting the traction generator is used as a motor. To facilitate starting without excessive drain on the battery, the generator is provided with a series of field winding.

165. Main Circuits

a. The main circuits for each power plant include the following equipment: Traction generator, traction motors, contactors for connecting the traction generator and traction motors, and a reverser for changing the direction of current in the traction motor fields.

b. The maximum engine utilization is obtained by automatic series-parallel connection of the motors when accelerating the locomotive.

166. Generator Field

The shunt field is supplied with current furnished by the generator itself, but may receive also part of its exciting current from the battery, depending on the scheme of connections.

167. Simple Troubles of Locomotives

a. If the engine fails to turn over when the starting button is pressed, the operator will:

(1) Close the battery and control switches.

(2) Close the starting contactor. (If it does not close, check for blown battery and control fuses; replace fuses if necessary. If the battery voltmeter registers a reading, it is an indication that the battery fuse is not blown. If the starting contactor still does not close, check for an open circuit at the starting button, at the operating coil of the starting contactor, or at the control switch.)

(3) If the starting contactor closes, but the engine will not turn over, see if the starting contactor main connections are defective or if the battery is discharged and needs to be recharged from an outside source.

(4) If the battery is not discharged and the engine cannot be started, check for a faulty generator, the most likely defects being poor ground connection and open or loose connections in the main generator circuit.

b. If the engine is operating but the locomotive will not move with the throttle in the first position, the operator will:

(1) Make sure that the line contactors close. (If they do not close, look for poor connections at the following points: interlocks on line contactors; contact fingers on throttle control switch; contact fingers on the controller at the operator's position; interlock fingers on the reverser; interlocks on starting contactors; the engine starting switches; or at line contactor operating coils.)

(2) If the line contactors close, but the locomotive does not move, the operator will:

(a) Release the brakes.

(b) Set the reverser in its proper position.

(c) See that the contacts are in good condition.

(3) If the foregoing steps do not remedy the trouble, the operator will:

(a) Apply a voltmeter and see if the traction generator voltage builds up. (If it does not, there is probably an open circuit in the traction generator shunt field circuit.)

(b) If the battery does not charge, check and replace any blown fuses in the charging generator circuits.

c. **LACK OF POWER.** (1) Lack of power in the engine may be caused by poor combustion, insufficient air, improper fuel, leak in fuel suction line, governor trouble, injector trouble, restriction in exhaust, incorrect timing, leaky exhaust valves, or a tight bearing or piston.

(2) Lack of power in the electrical system may be caused by low generator field excitation, which in turn may be caused by a faulty connection in the generator battery field circuit or a faulty auxiliary generator field contactor. Lack of power may also be the result of faulty traction motors or generators,

transition relay, current limit relay, or fuses blown in battery or exciter circuits.

d. **SMOKE AT EXHAUST.** Smoke at the exhaust normally is an indication of poor combustion chamber. Fuel in a partially burned condition will cause a black exhaust. If fuel is not igniting, the exhaust will show blue. Smoke may appear at light loads or upon starting because of low temperature of the combustion chamber. Misfiring, improper fuel, incorrect timing, a faulty injector or insufficient air also may be the cause of exhaust smoke.

168. Work Reports

After completion of each trip or day's work, a work report on the approved form will be filled out by enginemen.

Section III. MAINTENANCE OF LOCOMOTIVE

169. General

a. Maximum service is obtained from electric machinery only when it is kept dry and clean. All apparatus should be blown out with dry compressed air; parts accessible should be wiped off with clean wiping rags. Washed wiping rags are preferable to cotton waste as they are less liable to leave lint. Do not use air under high pressure for cleaning in the vicinity of exposed mica insulation as small flakes of mica will be blown loose, finally resulting in complete destruction of the insulation.

b. Oil is also destructive to insulating materials since it collects dust and dirt causing such materials to break down electrically. When lubricating electrical apparatus use extreme care to prevent the lubricant from coating the insulated parts; if any lubricant does spill on the equipment, it will be wiped off thoroughly with clean wiping rags.

c. All screws, bolts, and nuts which secure electrical connections will be kept tight to insure good contact. When a ground connection is made, the surface to which the connection is made will be cleaned thoroughly of all dirt, paint, or rust to assure good electrical contact.

d. Cement is used to advantage in repairing burned insulation such as arc chutes, sides of contactors, and switches.

e. Varnish is recommended for all cables exposed to dirt or moisture, especially where creepage is important; it has high insulating qualities and gives a smooth surface which cleans easily.

f. When varnishing control apparatus, use good quality insulating varnish.

g. During inspection of control equipment responsible personnel will watch for:

- (1) Loose nuts and screws.
- (2) Cotter pins missing or not-split.
- (3) Broken or weak springs.
- (4) Weak contact pressure on interlocks and relay contacts, and improper wipe and break.
- (5) Grease and dirt on insulating materials.
- (6) Worn or burned contactors.
- (7) Loose terminals and connections.
- (8) Broken insulators.

170. Running Gear and Mechanical Equipment

a. Responsible personnel will inspect the trucks and other parts of the running gear equipment as frequently as service conditions require.

b. The inspector will watch especially for loose or missing bolts and nuts, worn wearing plates, worn or broken bearings, defective gears and gear cases, and broken springs, and this inspection will include:

- (1) Gears and gear cases.
- (2) Motor axle caps and supporting bolts, nuts and linings.
- (3) Motor armature bearings.
- (4) Motor nose suspension bolts, springs, safety lugs and hangers.
- (5) Journal boxes, their wearing plates and bearings.
- (6) Pedestal wearing plates.
- (7) Equalizers and springs.
- (8) Dust guards.
- (9) Thrust plates at end of axles.
- (10) Hub liners.
- (11) Wheels and tires.

(12) Center plates and side bearings.

(13) Brake rigging, including cylinders, levers, hangers, pins, brake shoes, brake shoe heads and turnbuckles.

(14) Traction motor air connections, when used.

(15) Sander hose and pipes.

(16) Couplers.

(17) Motor leads and supporting clamps.

(18) Air brake hoses.

171. Engine and Generator Mounting

a. Alignment of the generator and engine through the flexible coupling is obtained by shims under the generator supports. In this method of mounting two conditions will be fulfilled, and changing one is apt to affect the other:

(1) Correct alignment of the coupling.

(2) Equalization of the generator air gap.

b. After the correct alignment has been obtained, the generator will be doweled to the sub-base; this facilitates realignment of the coupling and generator frame if the original alignment has been disturbed for any reason. However, the dowel pins will not be depended upon entirely for locating the generator frame as the engine may have been shifted on its base. The coupling therefore will be checked with a dial gauge and the air gap measured to make sure that realignment is correctly made.

c. If it becomes necessary to disconnect the generator from the engine or do any work that would disturb the alignment when reassembling the set, care will be taken to see that all of the shims under the generator supports are replaced in their original position. The dowel pins or body-bound bolts also will be replaced properly.

d. Inserting the dowel pins or body-bound bolts in the generator frame support and replacing the same thickness of shims does not always insure correct setting, as the engine may have been moved on the sub-base. To insure that the engine is located in exactly the same position as it was before disturbing the alignment, insert the dowel pins or the body-bound bolts in the engine base before trying to align the generator.

172. Filling and Draining Water System

a. In filling the water systems, the operator will—

(1) Close the drain valves.

(2) Tighten the drain plugs.

(3) Use only clean water.

(4) Fill through pipes located on the top of the radiators.

(5) Replenish water as required to offset loss from leakage and evaporation.

b. Water will be drained completely at least once each month to keep the concentration of water impurities from becoming too great. In draining the water cooling system, the operator will:

(1) Open all drain valves.

(2) Remove drain plugs wherever they occur in the water piping.

(3) Make certain that all parts of the system, including engine block and any water cooled auxiliaries, are drained completely.

173. Wheel Diameters

Keep the wheel diameter variation within limits given in Chapter 6, Section III, to avoid too great unbalance in the load between the motors. However, it is recommended that the wheel diameters be maintained as nearly equal as shop practice permits.

174. Lubrication

a. The proper lubrication of Diesel-electric locomotives is imperative and instructions will be followed carefully. The proper level and proper grade of oil will be carried in the crankcase at all times. Care will be taken to maintain a regular lubricating schedule on the remainder of the locomotive.

b. The frequent cleaning of metal edge type and changing elements on bag and waste type lubricating oil filters will increase the life of the oil by the absorption of carbon deposits and other impurities carried in the oil. Elements of bag and waste type filters will be changed each time the lubricating oil is changed.

c. If the height of the lubricating oil rises in the crankcase, it will be found that the oil is being diluted with water or fuel oil. The locomotive should be taken out of service and the reason for dilution determined and corrected.

(1) Dilution of the lubricating oil by fuel oil is serious, often causing bearing failures. Injectors will be cleaned, fuel connections checked for leaks, and injector rocker arms and push tubes checked for failure when dilution occurs.

(2) Dilution of the lubricating oil by water, although not as common, is equally serious. Cylinder heads and block, and cylinder liner seals will be checked for leaks.

d. When the locomotive first is put into service, each week add approximately 1 pound of proper lubricant to each gear case. Make frequent inspections through the filling openings to determine if there is a good film of grease on the teeth. The required amount and frequency of adding lubricant can then be determined. If considerable leakage of grease is noted and at the same time the gear teeth

show a good film of lubricant, more grease is being used than is necessary.

e. On swivel type truck locomotives lubricate the center plates at least once each month and more often if necessary. The oil used for the journal bearings will be suitable for this purpose. When working out a lubrication schedule it will be observed that:

(1) Ball and roller bearings require the right kind and quantity of clean lubricant and when grease lubricated, damage results more often from too *much* lubrication rather than too little.

(2) All type of bearings will be inspected frequently during their initial period of use to determine signs of wrong lubrication before serious damage can result.

175. Fuel Oil System

a. Care will be used in keeping fuel oil in a clean condition. Storage tanks or drums will be kept free from dirt; water, or rust scale. Care will be taken to exclude any foreign matter when transferring fuel from storage tanks to locomotive fuel tanks. Occasional flushing of the locomotive fuel tank will remove any sediment which has settled in the tank. This may be done by removing drain plug in the bottom of the fuel tank and allowing a small amount of fuel to drain out, then replacing plug.

b. Clean fuel is necessary because of the close clearances in the injection pump and injection nozzle mechanisms. The fuel oil injection system is protected by the extensive use of filters. Periodic cleaning or changing of elements of fuel-oil filters will prevent unnecessary fuel injections troubles.

176. Cooling System

a. The engine cooling system is filled through a filler pipe in the roof, or at the side of the truck under the platform of the locomotive. Fill until tank or standpipe overflows.

b. The use of water treating compound in Diesel engine cooling systems is strongly recommended. It reduces scale formation and caustic embrittlement within the engine.

c. The engine water outlet manifold thermometer in the cab provides an excellent means of determining faulty water circulation or lack of water. Abnormally high temperature, as indicated by this thermometer, is usually due to faulty water circulation or lack of water in the cooling system. Poor circulation is also indicated by excessive localized heating at various points in the cooling system. This may be determined by holding the hand at various points in question and making a comparison in the degree of heat.

d. Proper adjustment will be maintained on radiator fan belts to insure proper functioning of the cooling fan.

e. If the engine should overheat because of insufficient water in the cooling system, add *hot* water while idling the engine. If the engine is extremely hot, let it cool for an hour or so before adding any water.

f. Maintain as even a temperature as possible in cooling system (between 140° and 180° F., preferably 160° F. and never above 195° F.)

177. Electrical Equipment

a. Batteries are used in starting the engine and supplying the current for lights and other auxiliary units. These will be given an occasional test with a hydrometer to ascertain the amount of the charge carried. Water will be added daily to keep the correct level in the batteries. Gravity readings will not be taken immediately after adding water. All connections will be kept clean and tight.

b. On locomotives where a cut-out switch is provided for disconnecting the battery from the circuits, the switch will be opened when leaving the locomotive for an idle period or whenever working on any control circuits.

c. The master controller is used to select the direction of the locomotive. It is interlocked with the main throttle handle so that the controller cannot be thrown from forward to reverse or vice versa unless the throttle is in idling position.

d. The reverser is a drum switch for reversing the traction motor fields. It is operated by a double-cylinder air engine controlled by two magnet valves which in turn are controlled electrically by the master controller.

e. In event the engine does not rotate when starter switch is contacted, check the battery cut-out switch, fuses in the circuit, and starting contactors.

f. If the engine will operate but locomotive will not move, check control and auxiliary fuses and contactors in power circuits.

g. If the locomotive will move in one direction only, the trouble usually will be located in the wiring from the controller to the air operated magnet valve coil, in the interlocks on the reverse, or in low-control air pressure which is normally 70 pounds.

h. The reverser master controller handle will always be kept in the direction of movement of the locomotive, except when deadheading, when it will be placed in the neutral position.

i. The main generator supplies the electrical energy used to power the locomotive. The purpose of

the auxiliary generator is to charge the batteries. On some locomotives an exciter generator is used to excite the main generator fields. The traction motors convert the electrical power from the main generator to mechanical power and are geared to the locomotive axles.

j. Transition is the term applied to changing the traction motor electrical connections from series to series parallel. This is done to obtain the desired tractive effort and speed within the voltage operating limit of the generator.

Section IV. INSPECTION OF LOCOMOTIVE

178. General

Consult the proper War Department Technical Manual furnished with each type of locomotive for detailed instructions on how to make the inspections outlined in this manual.

179. Daily Inspection

a. MECHANICAL. (1) Check engines for lubricating oil, fuel oil, waste, fuel leaks.

- (2) Check wheels for flat spots.
- (3) Check sanders, bell, horn and throttle.
- (4) Check cooling fan and super-charge belts.
- (5) Check water pump packing.
- (6) Check journal boxes, and oil if necessary.
- (7) Drain sediment and water from fuel and lubricating oil filters.

(8) Check engine for cleanliness.

(9) Check any unlisted mechanical item for defects.

b. AIR COMPRESSOR AND AIR-BRAKE EQUIPMENT.

- (1) Check brakes and piston travel.
- (2) Check air compressor.
- (3) Blow out main air reservoir.
- (4) Check any unlisted item in this classification for defects.

c. ELECTRICAL. (1) Check batteries by noting speed of engine when starting.

- (2) Check battery charging equipment.
- (3) Check all lights.
- (4) Check any unlisted electrical item for defects.

180. 100-hour Operation Inspection

a. MECHANICAL. (1) Inspect all underneath equipment for loose bolts, defective or broken parts, and missing parts. Examine engine mounting for looseness. Check couplers and draft gear.

(2) Drain accumulated water and sediment from fuel tanks and filters.

(3) Lubricate journal box bearings and journal box pedestals.

(4) Lubricate clutch throwout collar.

(5) Maintain oil level in fuel injection-pump housing.

(6) Maintain oil level in engine crankcase; check oil pressure.

(7) Check for dilution of lubrication oil in engine crankcase.

(8) Inspect all drive belts for proper adjustment and condition.

(9) Lubricate radiator fan shaft bearings.

(10) Remove rocker box covers and inspect.

(11) Clean air-cleaning element and inlet tube.

(12) Clean crankcase breathers.

(13) Inspect all engine piping for leaks.

(14) Check all safety appliances, grab irons, steps, and handrails.

(15) Check engine speed, idle and full throttle, noting any unusual noise or pounding; determine cause and report condition to proper authority.

b. AIR COMPRESSOR AND AIR BRAKE EQUIPMENT.

(1) Drain water from main air reservoirs.

(2) Test air equipment and air brake operation.

(3) Maintain oil level in air compressor crankcase.

(4) Renew worn brake shoes, adjust brake travel.

c. ELECTRICAL. (1) Inspect generators and traction motors; clean with dry air.

(2) Check batteries for correct water level, specific gravity, and for loose or corroded connections; check charging rate.

(3) Maintain motor axle bearing oil level.

(4) Check operation of contactors, interlocks, and controls.

(5) Check load meters for engine power balance.

181. 400-hour Operation Inspection (in addition to 100-hour inspection)

a. MECHANICAL. (1) Clean or renew fuel filter elements and strainers.

(2) Clean or renew lubricating oil filter elements.

(3) Check transmission, adding lubricant if required.

(4) Change oil in fuel injection housing.

(5) Inspect traction motor gears; maintain lubrication.

(6) Lubricate traction motor blower fan bearings.

(7) Check valve clearances, examine valve springs and valve rocker arms.

(8) Clean and test fuel injection nozzles.

(9) Make visual inspection of crankcase for worn bearings or loose connecting rod bolts.

(10) Clean crankcase breather screens.

(11) Check oil in crankcase for sludge, dilution, and viscosity; change oil if necessary.

(12) Remove, clean, lubricate, and replace drive-sprocket chain.

(13) Drain cooling system, refilling with clean water, add specified water-treatment compound (do not drain when antifreeze is used in cooling system).

b. AIR COMPRESSOR AND AIR-BRAKE EQUIPMENT.

(1) Change air compressor crankcase oil.

(2) Clean air compressor air intake filter.

(3) Check operation of compressor governor and unloader valve.

c. ELECTRICAL. (1) Lubricate traction motor and all generator armature bearings; avoid overlubrication.

(2) Clean battery compartment and wash off batteries.

(3) Check starting motor and generator; clean with dry air.

(4) Clean and lubricate reverser; check operation of magnet valves.

(5) Clean contactor and interlock tips, renew defective tips, correct gap and spring tension.

(6) Check all electrical connections.

(7) Test control circuits.

(8) Check, adjust, and lubricate throttle control; correct engine idling speed,

182. 4,800-hour Operation Inspection (in addition to previous inspection requirements)

a. MECHANICAL. (1) Repack journal boxes and examine journal brasses.

(2) Change oil in roller bearing journal boxes.

(3) Repack motor axle bearings.

(4) Drain and clean out traction motor gear cases and refill with specified lubricant.

(5) Lubricate truck center bearings.

(6) Clean carbon and reface and grind valves.

(7) Check liner wear.

(8) Check pistons, piston rings, and wrist pins.

(9) Remove and examine main bearings and connecting-rod bearings.

(10) Make general inspection and clean interior of engine.

b. AIR COMPRESSOR AND AIR-BRAKE EQUIPMENT.

(1) Clean and lubricate air-brake equipment.

(2) Clean carbon from compressor valves.

c. ELECTRICAL. (1) Clean, inspect, and repair all electrical equipment.

(2) Inspect and lubricate operating cylinder piston leathers.

183. General Repairs

After 800,000 miles of service, the locomotive should receive an over-hauling, including:

a. Replacement or heavy repairs to Diesel engines.

b. Replacement or heavy repairs to generators; traction motors, steam generators, gear train, air compressors, cooling systems, pneumatic and electrical equipment.

c. Heavy repairs to body and trucks.

Section V. LOCOMOTIVES OUT OF SERVICE

184. Handling Locomotives "Dead on Wheels"

a. When the locomotive is hauled "dead on wheels," all switches will be opened including the battery cut-out switch. The air-brake "dead" engine features will be set.

b. If no antifreeze is used and there is danger of the engine cooling water freezing, drain the entire cooling system.

c. If the haul is long or the train speed exceeds the maximum safe speed of the locomotive, remove the pinions from the traction motors. For short hauls, remove traction motor brushes.

d. The messenger or pilot who accompanies the locomotive will be familiar with its working parts. He will be instructed to watch for hot journals and

check the condition of traction motors, making frequent inspections enroute. He will apply a good grade of oil to all moving parts. At the completion of the trip, he will make a written report of the out-of-ordinary conditions to proper authorities.

185. Preparation of Locomotives for Ocean Transit

In case it is necessary to prepare locomotives for oversea shipment, detailed instructions will be issued by proper authority.

186. Preparation of Locomotive for Storage

To prepare the Diesel electric locomotive for storage, responsible personnel will:

a. Run engine until thoroughly warm, then stop and drain lubricating system.

b. Place 1 gallon of rust-preventive oil in the oil pan.

c. Turn engine several revolutions with starter to force oil through the engine, then bring the engine up to full speed on its own power for a few moments, after which drain the excess oil from the lubricating system.

d. Take special precautions to protect the fuel injection system against corrosion and gum which causes sticking of delivery valves, plungers, control sleeves and nozzles. Just prior to shutting down the engine for the last time, 2 quarts of light rust-preventive oil with equal parts of kerosene to obtain a mixture of approximately the same viscosity as that of the fuel oil. Make sure that both the oil and kerosene are free from water and dirt, then proceed as follows:

(1) Run the engine until thoroughly warm; then drain the fuel from the entire system except the nozzles and high pressure lines from the injection pump. Drain the injection pump by loosening the large hex connection on the end opposite the inlet.

(2) Disconnect the feed line from the main fuel tank and insert the end of the line into a small container filled with the kerosene and oil mixture.

(3) Draw this mixture into the fuel system and vent.

(4) Start the engine and allow it to run until practically all of the mixture in the small container is drawn into the system.

(5) Drain the lubricating oil from the injection pump by means of the small drain plug in the base of the housing.

(6) Tape a piece of gasket material over the vent in the pump inspection cover and plug the overflow

if so equipped. Fill the lubricating-oil compartment with rust preventive oil mixture through the oil-gauge opening.

(7) Remove and clean the injection nozzles, removing the valve and body, and coating them with vaseline; reassemble parts to the engine.

e. Spray or paint inlet and exhaust valves, stems, spring and rocker arm shaft with rust preventive oil.

f. Spray or paint any and all surfaces having a tendency to rust, such as water pump shaft, fuel injection pump drive shaft, and the like.

g. Drain cooling system completely.

h. Remove all batteries and store them at a convenient location where they can be cared for properly during the shut-down period. (A battery deteriorates when it is not kept active.)

187. Preparing Locomotive for Operation after Storage

To place the Diesel engine in service after storage proceed as follows:

a. Drain the rust preventive mixture from the entire fuel system.

b. Drain the injection lines to the nozzles by disconnecting at the fuel pump.

c. Wash out the filters in clean fuel oil and refill with clean fuel oil.

d. Drain the lubricating oil compartment of the injection pump and refill with lubricating oil to the marking on the level gauge. Remove gasket and plug in vents.

e. Remove the injection nozzles and holders and wash in clean fuel.

f. Proceed as outlined under starting in paragraph 150.

LOCOMOTIVE CRANES, DERRICKS, AND PILE DRIVERS

188. General

a. The operator of a locomotive crane, derrick, or pile driver is responsible for proper operation, inspection and maintenance of the equipment in his charge. Lubrication and maintenance of such equipment will be in conformance with recommendations and instructions contained in the appropriate War Department Technical Manual accompanying the equipment.

b. Careful daily inspection by the operator and report of defects, followed immediately by necessary repairs, will reduce the cost of maintenance and keep equipment in operation for longer periods of time.

c. The stated capacities of a locomotive crane will not be exceeded. The lifting capacities at the various radii are given on a plate attached to the side of the crane; under no circumstances will the operator attempt to lift a load without knowing its approximate weight so that he can arrange to handle it within a safe working radius.

d. Before attempting to do any work under or about the machinery of a steam locomotive crane, or when leaving it for any length of time, the operator will close the stop valve in the main steam pipe near the boiler and open all cylinder cocks to the engines. Wheels will also be blocked to prevent undesired movement.

189. Locomotive Cranes and Derricks

a. **PLACING IN SERVICE.** Before placing a new crane in service, it is necessary that the required amount of ballast (plate punchings or similar scrap) be placed in the compartment in the rear extension.

b. **LOAD CAPACITY.** The capacity of the crane is listed on the plates located on each side of the machine. These capacities apply only when the load is directly under the hoisting block and are the maximum allowable; they will not be exceeded for any indicated radius.

c. **USE OF OUTRIGGERS.** When heavy loads are to be lifted, rail clamps are not sufficient. In addition, outriggers will be placed and carefully wedged with

the machine in level position to increase the diameter of the base and to prevent upsetting the machine.

d. **OVERLOADING.** It must be understood that the radius of a locomotive or wrecking crane is the horizontal distance from the crane's center pin to the center of gravity of a suspended load. The machine's capacity at different radii is plainly indicated and will not be exceeded.

e. **LUBRICATION.** The service a machine renders depends primarily upon the attention given to its proper lubrication. The object of lubrication is to prevent friction. This is accomplished by using the proper oil, grease, or other lubricant to form a film between the bearing surfaces. (See appropriate War Department Lubrication Orders.)

f. **REPAIRS.** The efficiency of a machine depends not only on the manner in which it is operated, which includes its proper lubrication, but it also is based on whether or not defects are noted as they develop. If the operator is not able to correct these troubles, they should be reported immediately to proper authority for correction. The operator should note any abnormal condition and take corrective measures immediately to prevent damage to the equipment and avoid unnecessary heavy repairs. At the end of the day's work, a careful inspection of the machine will be made and report of defects entered on WD AGO Form No. 55-226 (ch. 12).

g. Every locomotive crane boiler will receive careful and necessary attention to insure proper service. Operating personnel will—

(1) Give proper attention to the boiler while it is in his care.

(2) See that water is carried neither too high nor too low (two gauges or half a glass is proper amount).

(3) Correct all leaks immediately.

(4) Keep ash pan clean.

(5) Employ proper method of firing.

(6) Blow boiler and gauge cock as frequently as water conditions require.

(7) Never depend on water gauge glass alone for correct indication of water level but use all gauge cocks, beginning at the bottom to prevent sticking; also, frequently blow out the gauge glass.

(8) Wash boilers at least once each month and more often when water conditions require it. At each boiler wash period, the operator will:

(a) Clean the water tank and wash and clean the spindles of gauge cocks and water glass cock.

(b) Make a report of all boiler washout on WD, AGO Form No. 55-231. (See Chapter 12.)

h. (1) Preparation for firing up actually begins when the crane is put away at the end of a work-day or shift. The operator will—

(a) Leave sufficient water in the boiler for firing up on succeeding shifts but never less than two gauges nor more than three.

(b) Clean thoroughly the fire box and ash pan.

(c) Cover the stack.

(d) Drain cylinders and reservoirs.

(e) Close the throttle.

(f) Turn reverse lever to central position.

(g) Block the wheels.

(2) Before starting the fire, the operator will make certain that—

(a) Sufficient water is in the boiler.

(b) Stack cover is removed.

(c) Throttle is closed.

(d) Reverse lever is in neutral.

(e) Wheels are blocked.

(3) Start fire. (See sec. II, ch. 5, on firing steam locomotives.)

i. Before moving the crane to begin the day's work or shift, the operator will inspect the machine carefully to see that it is in proper condition for service. This inspection will include inspection of fire-box, boiler and machinery; testing water glass, gauge cocks; injectors; brakes and whistle; boom, rigging and gearing.

j. Always use a rerailer or car replacer, or its equivalent, to rerail a crane and haul the crane back on the track by some external power. When the crane is operated around a sharp curve, the heaviest part of the crane will be forward and to the outside of the curve. This will minimize the chances of the flanges mounting the rail and derailing the crane.

k. In preparing a self-propelling crane for movement from one location to another by other than its own power, certain preparations will be made to insure safe movement of the crane. Operating personnel will—

(1) Anchor the revolving portion of the crane at a position parallel to the center line of track and facing the direction of movement; to make secure, use tie bars or guy rods at both the front and rear ends of the rotating base.

(2) Be sure that truck wedges are disengaged between the car and the truck to allow adequate clear-

ance. Block the rear end of the rotating bed to hold the upper portion rigid with respect to car; place this block in position before removing the boom.

(3) When the crane is moved for a short distance at restricted speed, lower the boom to clearance position, place the transmission shifter lever in neutral position and allow the gears to turn freely. Where boom is more than 35 feet in length and the crane is moved for a long distance at normal train speed, remove the boom from the crane and ship in an accompanying gondola. Rest one end of the boom on the floor of the car; place the other end across the sides of the car and hold in place by stakes in the side pockets of the car.

(4) To prevent mesh with axle gear, disengage shifting pinions under crane by means of the shifter crank located at the side of the crane. Where no shifter crank is provided, disengage the sliding spur pinions under the crane by hand. On some types, the axle gears are disengaged by removing the split collar, shifting the frame to left and applying split collar to right of frame to hold gears in disengaged position. Exercise care to see that collar is placed with grease holes toward the gear case.

(5) Test the brakes and place in position for movement "dead-in-tow" by cutting out the lower brake valve and blocking the valve handle in running position.

(6) Properly lubricate all moving parts.

(7) Make certain that necessary tools and spare parts are shipped with the crane.

190. Pile Drivers

Personnel responsible for the operation of pile drivers will:

a. See builders' instructions for limiting capacities and the maximum back positions when handling piles; do not exceed these figures.

b. Place blocking under the forward end of the car when working.

c. Set car brakes or block wheels when working on a grade.

d. When preparing this machine to be hauled over the road by an engine:

(1) Disengage the sliding propelling gear which meshes with the axle gear; hold the propelling gear against the bracket.

(2) Properly guy the truss.

(3) Remove the hammer.

(4) Lock the truss to the turntable and lock the rear of the truss to the car.

191. Monthly Inspection

In the monthly inspection of locomotive cranes, derricks and pile drivers, responsible personnel will:

a. Examine propelling gears and see that they are lubricated properly.

b. Examine all clutches and friction members.

c. Clean and lubricate the machinery and make necessary repairs.

d. Examine the condition of the sheaves of the boom cable and main hoist and properly lubricate.

e. Examine the conditions of all cables for safe operations and report the condition of cables on the back of the monthly inspection form and the annual inspection form. When new cables are applied, so state.

f. Inspect and lubricate all journal boxes.

g. Examine and check batteries.

h. Examine and lubricate the running gear.

i. Examine the fuel tank and piping system.

j. Examine and check the voltage regulator.

k. Examine and check internal combustion engines.

192. Processing and Packing for Oversea Shipment

When a locomotive crane, derrick or pile driver is prepared for oversea shipment, maintenance personnel will be governed by the instructions issued by proper authority.

193. Hoisting Slings

Personnel responsible for the use of hoisting slings will:

a. Keep within the limits of a "safe load" or the maximum load in pounds that may be applied with safety to the sling. Avoid weakening the slings and reducing the safe load by permitting such conditions as—

(1) Twisting slings.

(2) Sudden excessive strain.

(3) Long usage.

(4) Exposure to weather.

(5) Sudden sharp variation in the angle of slings due to shifting of the load.

b. Evenly distribute the load. (Lift the load from the center of hooks; never lift from the points.)

c. Tank up the slack gradually and start the load slowly.

d. Be sure that coupling links, rings, and hooks are of sufficient strength to withstand safely the maximum load of the slings.

e. Inspect carefully once each month, all wire rope, chain and manila rope used as hoisting slings; make certain that this equipment is kept free from kinks, twists, and knots.

f. Keep wire rope lubricated to reduce wear and prevent rust.

g. Inspect carefully individual links of the chain or the chain in general, and anneal if cold worked condition is indicated by battered, peened, polished or gouged links.

h. Keep all wire rope, chain and manila rope used in hoisting at some designated place where heavy objects will not be placed on them causing damage to slings.

i. When lifting an object, keep slings as near to vertical as possible. Avoid too flat an angle; this greatly increases the strain on the slings and reduces the amount of safe load.

j. Do not use a chain which is stiff or partially stiff from overloading or through repeated use. Do not use chains if a cross-section of the metal is worn; scrap such defective equipment and replace with a new chain.

k. Listed in the following tables are the safe loads in pounds for wrought iron chain (table I), for manila rope (table II) and for extra pliable hoisting rope (table III), as applied to various sizes and diameters of material;

Table I. Safe loads in pounds for wrought iron chain

Size of chain (in.)		60°	45°	30°	20°	15°	10°	5°
¼	1060	1840	1500	1060	725	550	370	185
⅕	1655	2870	2340	1655	1130	855	575	290
⅜	2385	4130	3370	2385	1630	1235	830	415
½	3250	5630	4595	3250	2220	1680	1130	570
⅝	4240	7340	5995	4240	2900	2195	1470	740
¾	5370	9300	7595	5370	3670	2780	1865	935
⅞	6630	11480	9375	6630	4535	3430	2300	1155
1	9540	16520	13490	9540	6525	4940	3310	1665
1 ⅛	12960	22450	18330	12960	8865	6710	4500	2260
1 ¼	16950	29360	23970	16950	11595	8775	5885	2955
1 ⅝	20040	34710	28340	20040	13710	10370	6960	3495
1 ¾	24750	42870	35000	24750	16930	12810	8590	4315
1 ⅞	29910	51800	42300	29910	20460	15480	10385	5215
2	35600	61660	50350	35600	24350	18430	12360	6210
2 ¼	41800	72400	59110	41800	28590	21640	14510	7290
2 ½	48450	83910	68520	48450	33140	25080	16820	8450
2 ⅞	55300	95780	78200	55300	37825	28620	19200	9645
3	63300	109640	89520	63300	43300	32760	21980	11040

Table II. Safe loads in pounds for manila rope

Diameter (in. nominal)	Circumference (in.)		60°	45°	30°	20°	15°	10°	5°
⅝-6 yarns	½	85	145	120	85	60	45	30	15
¾-6 yarns	¾	100	175	140	100	70	50	35	17
⅞-9 yarns	1	170	295	240	170	115	90	60	30
1-12 yarns	1 ⅛	210	365	300	210	145	110	70	35
1 ⅕-15 yarns	1 ¼	250	435	355	250	170	130	85	45
1 ⅜-21 yarns	1 ½	350	610	495	350	240	180	120	60
1 ½	1 ¾	450	780	635	450	310	230	155	80
1 ⅞	2	570	990	805	570	390	295	195	100
2	2 ¼	700	1210	990	700	480	360	240	120
2 ¼	2 ½	845	1460	1195	845	580	440	290	150
2 ½	2 ¾	1000	1730	1410	1000	685	520	340	175
3	3	1170	2025	1655	1170	800	605	400	205
3 ⅕	3 ¼	1360	2355	1925	1360	930	700	465	235
3 ⅜	3 ½	1570	2720	2220	1570	1075	810	535	275
3 ½	3 ¾	1785	3090	2525	1785	1220	925	610	310
3 ⅞	4	2030	3515	2870	2030	1390	1050	690	355
4	4 ½	2500	4330	3535	2500	1710	1295	855	435
4 ¼	5	3070	5320	4340	3070	2100	1590	1050	535
4 ½	5 ½	3645	6310	5155	3645	2495	1885	1245	635
5	6	4285	7420	6060	4285	2930	2220	1460	745
5 ¼	7	5500	9525	7780	5500	3760	2845	1875	960
5 ½	8	7000	12125	9900	7000	4790	3625	2390	1220
6	9	8710	15085	12320	8710	5960	4510	2970	1520
6 ¼	10	10430	18065	14750	10430	7135	5400	3560	1820
6 ½	11	12340	21370	17450	12340	8440	6390	4210	2150
6 ¾	12	14430	24990	20410	14430	9870	7470	4925	2515

Table III. Safe loads in pounds for extra pliable hoisting rope, plow steel hemp center

Diameter of rope (in.)	No. of strands	No. of wires to strand		60°	45°	30°	20°	15°	10°	5°
1/4	8	19	860	1490	1220	860	590	445	295	150
5/16	8	19	1340	2320	1895	1340	920	690	460	230
3/8	8	19	1880	3260	2660	1880	1290	970	640	330
7/16	8	19	2520	4360	3560	2520	1720	1300	860	440
1/2	8	19	3280	5680	4640	3280	2240	1700	1120	570
9/16	8	19	4120	7140	5830	4120	2820	2130	1400	720
5/8	8	19	5000	8660	7070	5000	3420	2590	1710	870
3/4	8	19	7120	12330	10070	7120	4870	3690	2430	1240
7/8	8	19	9600	16630	13580	9600	6570	4970	3280	1670
1	8	19	12480	21620	17650	12480	8540	6460	4260	2180
1 1/8	8	19	15760	27300	22290	15760	10780	8160	5380	2750
1 1/4	8	19	19360	33530	27380	19360	13240	10020	6610	3380
1 3/8	8	19	23320	40390	32980	23320	15950	12070	7960	4070
1 1/2	8	19	27600	47800	39030	27600	18880	14290	9420	4810
1 3/4	6	37	41600	72050	58830	41600	28450	21530	14190	7260
1 7/8	6	37	47600	82440	67320	47600	32560	24640	16240	8300
2	6	37	54000	93530	76370	54000	36940	27950	18420	9420

GASOLINE-MECHANICAL LOCOMOTIVES

194. General

a. Before the locomotive is started, the radiator will be filled with clean, soft water; avoid the use of alkaline water which will deposit sediment and eventually clog the radiator core. Sufficient oil will be placed in the crankcase so that oil level indicator registers FULL or HIGH. A supply of fuel will be in the fuel tank and the fuel shut-off cock in open position.

b. Both compartments of the transmission will be filled to the proper level with proper lubricant.

c. Lubricating instructions furnished with each locomotive will be followed and the proper grades of oil and grease will be used. The life of the locomotive depends upon the quality of lubricant used and the lubrication attention given to it.

d. Only lintless rags, not waste, will be used for wiping the locomotive or engine.

e. Sandboxes will be filled out of doors, with the engine hood closed. Only dry, sharp sand, washed free from salt and clay, will be used.

f. Lubrication and maintenance of engine, magneto, and starting and lighting equipment will be in conformance with the appropriate War Department Technical Manual accompanying the equipment. Copies of these instructions will be in the possession of the officer in charge. If not otherwise available, request will be made to the chief of transportation, to supply a set of instructions.

195. Operation of Locomotive

a. To start the engine, the operator will:

- (1) Turn on ignition switch.
- (2) Turn on both distributor and magneto switches.
- (3) Pull the choke out.
- (4) Use the starter button.
- (5) In cold weather pull the primer out two or three times before using starter button.
- (6) Operate engine on either magneto or distributor or on both.
- (7) Allow engine to run a few minutes before operating locomotive.

b. To start the locomotive, the operator will:

(1) Shift the gears and operate the clutch and throttle as for an automobile or truck. (Practice is necessary to prevent clashing of gears or stalling the engine.)

(2) Control the forward and reverse motion of the locomotive by the forward and reverse lever.

(3) After shifting this lever make certain that it is latched securely in place.

(4) When reversing direction, place the gear shift lever in low speed and then release clutch. Bring locomotive to a full stop before reversing.

(5) Start in low gear regardless of the weight of the train.

(6) As the train and locomotive gain momentum, release clutch and shift the gears to second speed and on up through third and fourth speeds as rapidly as momentum will permit.

(7) Operate locomotive in high gear whenever possible and control the speed of the train by the throttle; never operate at a higher speed than designated limit.

c. In using locomotive brakes, operator will:

(1) Never attempt to brake locomotive by engine compression while descending a grade; such action will burn out bearings and possibly break connecting rods.

(2) Disengage the transmission when not under power and control the speed by brakes; do not use engine clutch or transmission as a brake.

196. Precautions

To prevent unnecessary deterioration of locomotives, responsible personnel will:

a. In extremely cold weather use full choke in cranking the engine, and if necessary, prime each cylinder through the priming cups or spark plug holes.

b. Never operate a warm engine with choke control pulled out. (This will cause engine to labor or stop and will dilute the crankcase oil).

c. Never tamper with the engine governor unless thoroughly familiar with its construction and operation.

d. Turn down grease cups on water pump once

each day; never remove grease cups to install pressure type grease gun fittings.

e. Keep engine and all exposed parts clean.

f. Check cause of back-firing or misfiring in the engine and correct.

g. Protect the end of the exhaust pipe from rain if the engine is idle.

197. Possible Causes of Engine Trouble

a. When the engine is hard to start, the operator will—

(1) Check battery for charge, for loose terminals, or for low solution.

(2) Check the magneto for worn or sticking brushes; for damaged or water-soaked coil; for worn or sticking points, or for faulty condenser.

(3) Check the distributor points to see if they are worn, or pitted, water-soaked, or sticking.

(4) Check to see if fuel flow is obstructed, the carburetor flooded, or water in the fuel.

(5) Check for loose or defective wiring; bad spark plugs; loose throttle or governor valve; leaking gaskets; non-seating valves; and improper timing.

b. Excessive smoke from exhaust may be caused by:

(1) Too much oil in the crank case.

(2) Carburetor needle valve open too far.

(3) Sticking or leaking float.

(4) Worn bearings, rings or cylinders.

c. Explosion in muffler is usually caused by:

(1) Retarded or weak spark.

(2) Valves not seating or out of time.

(3) One or more cylinders not firing.

d. Engine knocks arise from:

(1) Excessive carbon.

(2) Loose bearings.

(3) Valves not free on guides, or tappet clearances too great.

(4) Worn pistons, pins, or cylinders.

(5) Engine overheated or fuel not suited to engine.

(6) Loose flywheel.

(7) Lack of water or oil.

e. When the engine misfires, it may be caused by—

(1) Spark plugs fouled, cracked, shorted, or with improper gap.

(2) Defective wiring.

(3) Ignition breaker points sticking or with improper gap.

(4) Dirt or water in fuel system.

(5) Valves warped or broken; tappets sticking, or improperly adjusted.

(6) Gaskets leaking.

f. When engine lacks power, check for—

(1) Valves warped, sticking, or seats worn.

(2) Cylinders or pistons worn or scored.

(3) Piston rings worn, weak, broken or sticking.

(4) Improper fuel mixture, or fuel not suited to engine.

(5) Muffler clogged.

g. When the engine overheats, it is often caused by—

(1) Lack of water; obstructed water hose; clogged radiator.

(2) Fan belt slipping.

(3) Lack of oil or diluted oil.

(4) Improper ignition timing or valves leaking.

(5) Improper fuel mixture.

h. Poor compression results from—

(1) Valves not seating properly; tappets sticking, set too close, or incorrectly timed; weak valve springs.

(2) Piston rings sticking, weak, worn, or broken.

(3) Loose or cracked spark plugs.

(4) Oil too thin to seal piston rings.

(5) Gaskets leaking.

198. Inspection

a. The same general procedure will be followed as outlined for Diesel-electric locomotives (see ch. 7) with the additional inspections of the gasoline engine.

b. Report forms required for Diesel electric locomotives will be used for gasoline mechanical locomotives.

199. Maintenance

a. Daily maintenance. It will be the daily responsibility of maintenance personnel to:

(1) Check the level of the oil in the engine and air compressor and add oil to bring the level up to the "full" mark on the gauges.

(2) Fill the air compressor by removing the top plug and pouring in oil until it overflows.

(3) Give one turn to the grease cup on the distributor.

(4) Oil the surfaces between the axle and gibs in the journal boxes.

(5) Drain the air reservoir while the system contains air under pressure.

(6) Drain the air strainer.

(7) Fill the gasoline tank, radiator, and sand boxes.

(8) Clean the oil filter on the side of the engine by giving the handle several complete turns.

(9) Examine the gasoline filter at the carburetor. If water and sediment are present, close shutoff, remove bowl, and clean.

b. WEEKLY MAINTENANCE. In addition to daily maintenance (*a* above), maintenance personnel will—

(1) Drain the engine oil while hot by removing the plug in the oil pan.

(2) Remove the oil screen and wash in kerosene.

(3) Put proper quantity and grade of new oil in the engine.

(4) Remove oil filter, drain sump by removing drain plug, flush the filter with gasoline, and reinstall.

(5) Check the height of oil in both compartments of the transmission and add oil in each compartment to restore to the proper oil level.

(6) Clean the air filters on carburetor and air compressor by washing in light oil.

(7) Add mixture of oil and kerosene to the clutch until mixture runs out of overflow.

(8) Lubricate the clutch sleeve with proper lubricant.

(9) Lubricate the fan, clutch throwout bearing, brake shaft, cross equalizer, and jackshaft and bearings. Fill the distributor grease cup with cup grease. Oil the magneto, generator and Bendix drive with light oil.

(10) Oil the brake pins, speed change lever and reverse lever.

(11) Check the fan and air compressor belts; adjust if necessary, to eliminate slippage. Use no belt dressing and avoid getting oil or grease on the belts or pulleys.

(12) Check the brake shoe travel and adjust so that the shoe travel does not exceed $\frac{1}{2}$ inch.

(13) Check the air brake system for leaks by applying air brakes and noting reduction in air reservoir pressure. Do not allow the pressure to drop over 5 pounds per minute. If the leak is greater than this amount, trace and eliminate it.

(14) Check battery with hydrometer. See that all cells show proper operating gravity. If gravity is low, increase the charging rate on generator. If gravity is high, reduce the charging rate. Add distilled water to the battery to bring level to $\frac{1}{2}$ inch above the plates.

(15) Check all nuts, fastenings, and connections.

c. MONTHLY MAINTENANCE. In addition to daily and weekly maintenance (*a* and *b* above), maintenance personnel will—

(1) Drain the air compressor and refill with oil.

(2) Drain and refill the clutch with proper mixture of oil and kerosene.

(3) Remove and clean spark plugs, check the gap with a gauge and reset points if necessary.

(4) Clean breaker points in the distributor, check the gap with the gauge and reset points if necessary.

(5) Clean points in the magneto, check the gap and reset points if necessary.

(6) Clean and adjust chains, making sure that chains do not have initial tension nor are not slack enough to flap at high speeds.

d. BIMONTHLY MAINTENANCE. In addition to daily, weekly and monthly maintenance (*a*, *b*, and *c* above), maintenance personnel will:

(1) Drain the transmission and refill with proper grade and quantity of oil.

(2) Remove chains, wash in kerosene, soak in engine oil, and replace.

e. SEMIANNUAL MAINTENANCE. In addition to daily, weekly, monthly and bimonthly maintenance (*a*, *b*, *c*, and *d* above), maintenance personnel will—

(1) Remove axle bearing caps and flush with kerosene; replace caps and put proper lubricant in each bearing.

(2) Remove the brake cylinder head and piston; clean and lubricate with brake cylinder lubricant.

(3) Test the air gauge with a master gauge, check the air safety valve and reset if necessary; set the safety valve to open at 80 pounds.

(4) Remove the engine cylinder heads, clean off carbon and grind valves.

(5) Remove the air compressor and clean of carbon.

(6) Reset the air compressor unloader to cut out at 79 pounds.

200. Preparation for Ocean Transit

In event it is necessary to prepare gasoline mechanical locomotives for oversea shipment, detailed instructions will be issued by proper authority.

OPERATION AND MAINTENANCE OF AUTO-RAILERS

201. General

a. Auto-railers are dual-purpose vehicles for operation on both railroad tracks and highways. They are provided with steel-flanged wheels for holding their pneumatic tires on the rails. These flanged wheels are retractable so that auto-railers can be moved from the track and operated on roads with equal facility. Auto-railers utilize heavy-duty automotive units and construction in general and supplement standardized railroad equipment.

b. The coefficient of friction of auto-railer tires on dry rails is 0.85. This results in great tractive and braking ability for such relatively light vehicles. Auto-railer tires are of the "squeegee" type and provide a coefficient of friction of approximately 0.60 on wet rails and a coefficient of friction of approximately 0.40 under conditions of frost, ice, and snow. Sanding auto-railer tires improves traction under slippery conditions and is most effective because of the large area of contact of the tire on the rail and through the use of the "squeegee" tire grooves. Under extreme winter conditions steel tire chains, developed especially for auto-railer tires, are used for running on the rail.

c. Auto-railers are normally placed on railroad tracks at road crossings or other areas where the roadway is approximately level with the top of the rail. The rear pilot wheels are placed on the rails first with pressure on them before steering the front tires onto the rail and dropping the front pilot wheels. When the pilot wheels are on the rails, the steering gear is locked with the front tires in the straight forward position.

(1) Auto-railers can be placed on the track where there is no road crossing by using railing devices which are placed on the rails with ramps resting on the ties. Where auto-railers are regularly used as a part of the production equipment, special railing chutes are provided along and between the rails so that the auto-railers can be steered into them and both front and rear pilot wheels lowered without stopping. Similarly auto-railers can be driven off the track without stopping. Trains of auto-railers, of

course, require railing chutes to get on the track quickly.

(2) Pilot wheels are raised and lowered by the operator in the cab using either compressed air or power hydraulic controls. Another method is through manual controls at each end of the unit; these are conveniently located and easy to operate.

(3) In some models with compressed air and hydraulic controls, inverted periscopes are used so that the operator can see the rails during the railing operation; floodlights are provided under the floor for use at night.

d. Hardened steel flanged wheels with full width flanges and treads operate on two large tapered roller bearings. These wheels do no driving or braking. They are insulated to reduce vibration and eliminate ringing noises, and can be provided with electrical bonding for operating semaphores, crossing bells, flashers, lights, and similar signals. Pilot wheels are designed to hold the tires on the rail and to carry all of the weight not carried by the tires; they support the entire weight in case of tire blow-outs.

e. The pilot wheels are attached to the main frame, using the principle of three-point suspension, and through other positive flexible means. Pilot wheels are permitted to follow irregularities on the track with full pressure applied on them independently from the pneumatic tires and, inversely, the tires can follow uneven track independently of the pilot wheels.

202. Operation and Maintenance

The operation and maintenance of auto-railers follows closely the regulations for gasoline locomotives. Instructions contained in War Department Technical Manuals furnished with the equipment, will be followed to obtain proper performance.

203. Types of Auto-Railers

There are four common types of auto-railer locomotives:

a. Model E-1 locomotive, powered with 125 h.p. gasoline engine, has two-axle drive affording a maximum tractive effort of 10,200 pounds. Equipped with

railroad couplers, air brakes and high speed reverse gear, it has compressed air auto-railer equipment and 16-inch pilot wheels. It can be used for hauling freight cars and auto-railer cars, as well as a 5-ton load in the body. It is most practical for hauling portable light plants and wrecking equipment as it can operate on rails or in adjacent fields in servicing wrecks. It is used frequently also for inspection work, stringing ties, laying rails, and similar work. This model locomotive has electropneumatic controls for raising and lowering pilot wheels on auto-railer express cars, thus adding to its switching and carrying utility.

b. Model E-4 locomotive, equipped with 90 h.p. engine and powered hydraulic auto-railer equipment, has 16-inch diameter pilot wheels. It operates at the same speed in both directions and is equipped with railroad couplers at each end. It will carry a 14-foot stake body with 5,000 pounds load or a 4-yard dump body. This locomotive is frequently equipped with snow plows, winches, and other accessories. It has a rated drawbar pull of 5,800 pounds. It is not equipped with locomotive air brakes except as optional equipment. Model E-4 is an ideal size for sup-

plementing large locomotives as it can get on the rails and switch from 5 to 10 cars before a large locomotive can be made available. It is sufficiently sturdy for daily switching service and for all-around use in moving freight, snow plowing or other services.

c. Model E-14 locomotive has a 235-h.p. engine and three-axle drive. It utilizes power hydraulic auto-railer equipment with 16-inch pilot wheels and features a wide cab with two driving positions. Hydraulic transmission and high-speed reverse gear are standard equipment. It has a rated drawbar pull of 15,300 pounds. It does not have a freight body, but can travel on the road from one yard to another, around cars, and into shops. It can do a heavy job of pulling or snow plowing on the highway as well as on rails.

d. Model E-21 locomotive, weighing 24 tons, is a double-end unit with two power trucks, each equipped with 235-h.p. engine with hydraulic transmission and three-axle drive. It is available in both straight rail and road-and-rail designs and has a drawbar capacity of 36,000 pounds. It can be extended into a multiple unit since the air controls in the cab are adaptable for operating the engines and railroad air brakes.

SURFACE MAINTENANCE

204. Repainting and Lettering

a. All equipment will be kept reasonably clean and well painted to prevent rust. All lettering and numbering will be clear and legible; personnel concerned will repaint and restencil when necessary to accomplish desired results.

b. Under no circumstances will the original standard Army color and method of stenciling on any locomotive be changed or altered unless authorized by the chief of transportation, zone of interior, or by the railway grand division headquarters, theater of operations. Information as to color or paint, size and locations of letters and numbers, will be obtained from the authorized sources.

c. All paint and paint materials will conform to applicable government specifications.

d. All paint will be applied according to the painting schedule which conforms to the drying times. Where more than one coat is necessary, a subsequent coating will not be applied until preceding coating has dried sufficiently.

e. All surfaces will be cleaned; free from oil, grease, scale, rust and weld splatter, before any primer is applied.

f. Maintenance personnel of steam locomotives, immediately following the monthly boiler washout, will cover the front and sides of the smokebox and the exterior surfaces of the firebox and ash pan with a good heat resistant graphite paint, and touch up deteriorated paint spots on jacket, cab, tender, running gear, and auxiliary units with a locomotive black paint.

g. Maintenance personnel of locomotive cranes, derricks, and pile drivers will cover the firebox with heat resistant paint following the monthly boiler washout, and if it is needed, touch up other surface spots with locomotive black paint.

h. Maintenance personnel will cover deteriorated paint spots on gasoline tanks with paint of appropriate color and grade, or with locomotive black paint.

i. The tender, running gear, frame, and similar parts will be protected with locomotive black paint when required.

j. Locomotives or cranes, when not in use and when local conditions permit, will be sheltered in order to decrease the rate at which paint and metal surfaces deteriorate.

OPERATING AND INSPECTION REPORT FORMS

205. General

a. Included in this chapter are operating and inspection report forms for steam and other than steam locomotives and locomotive cranes. These will be maintained or prepared by all installations in the zone of the interior and in theaters of operations.

b. Also included in this chapter are general and specific instructions governing the preparation of these operating and inspection reports; personnel responsible for their preparation will be guided by these instructions.

206. WD AGO Form 55-115. (Daily Assignment Worksheet for Locomotives and Locomotive Cranes and Record of Repairs) (fig. 17)

This form will be completed by the individual in charge of maintaining the equipment and will be retained on file at the installation where the equipment is operated. In order that the mechanical record of the equipment be accessible at all times, completed forms will be clipped at the left edge in a file folder. This record will accompany the equipment if it is transferred to another installation or sent to an Army railroad repair shop for repairs. Attention is especially directed to the reverse side of Form 55-115. Only such data as the date repairs are made, job order number, parts requisition number, and a brief description of repairs will be recorded here. The job order and parts requisitions will be kept as a permanent record and may be referred to if a more complete description of the parts and nature of repairs is necessary. Standard War Department job order forms, parts requisition forms, and request for job order forms will be used in connection with the repair of the equipment. These are available at each War Department installation.

207. WD AGO Form 55-116. (Locomotive and Locomotive Crane Maintenance and Inspection Chart) (fig. 18)

This form will be completed by the individual in charge of maintaining the equipment and will be retained on file at the installation where the equipment is operated. If the operator of the equipment is also

responsible for its maintenance, he will make the several checks required during the course of the day and will maintain the chart.

208. WD AGO Form 55-150 (Ash Pan and Spark Arrester Inspection and Repair Record) (fig. 19)

This form will be completed by the individual in charge of maintenance of this equipment at each engine terminal shop or other location where inspection and repairs are made to ash pans and spark arresters. He will designate personnel to make the several checks required at each washout period or whenever it is necessary to make an examination of this equipment.

209. WD AGO Form 55-151 (Alteration Report for Steam Locomotive and Locomotive Crane Boilers) (fig. 20)

a. When any repairs or changes are made which affect the data shown on the Boiler Specification Card, WD AGO Form 55-152 (see par. 210) an alteration report giving details of such change will be filed within 30 days from the date they are completed. It will be prepared in triplicate by the individual in charge of making the alteration on the equipment on authority of the mechanical engineer, railway grand division headquarters, theaters of operations, or chief of transportation, zone of the interior. One copy will be retained on file at the installation where the equipment is operated and two copies will be forwarded to the railway grand division headquarters or the chief of transportation.

b. This report will cover—

(1) Application of new barrel sheets or domes.

(2) Application of patches to barrels or domes of boilers or to the portion of wrapper sheet of crown bar boilers which is not supported by staybolts.

(*a*) Report of patches will be accompanied by a drawing or blue print of the patch, showing its location in regard to the center line of the boiler, giving all necessary dimensions, and showing the nature and location of the defect. Drawings of patches will also show whether the plate underneath such patches was removed. If the defective plate was not removed,

**DAILY ASSIGNMENT WORKSHEET
FOR LOCOMOTIVES AND LOCOMOTIVE CRANES**

STATION _____
LOCOMOTIVE U. S. A. No. _____
MONTH AND YEAR _____

DAY OF MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
	HOURS EQUIPMENT IS OPERATED EACH SHIFT (Taken from Operator's Daily Time and Report Record, W. D., T. C. Form No. 263. Enter X in spaces when equipment is idle).																															
SHIFT HOURS OR RUN NO.																																
1.																																
2.																																
3.																																
TOTAL HOURS																																
SERVICE { For Internal Combustion Locomotives and Cranes only																																
WEEKLY OR 125-HOUR SERVICE (1 PERIOD)																																
MONTHLY OR 500-HOUR SERVICE (4 PERIODS)																																
QUARTERLY OR 1,500-HOUR SERVICE (12 PERIODS)																																
SEMIANNUAL OR 3,000-HOUR SERVICE (24 PERIODS)																																
ANNUAL OR 6,000-HOUR SERVICE (48 PERIODS)																																
OIL CHANGE—ENGINES (— HR.)																																
OIL CHANGE—AIR COMPRESSORS (— HR.)																																
HOURS REQUIRED FOR SERVICE																																
SUPPLIES																																
ANTIFREEZE (GALLONS) _____ TYPE _____																																
BOILER COMPOUND (QUARTS)																																
CAR (OR BLACK) OIL (GALLONS)																																
FUEL—DIESEL FUEL OIL { GALLONS GASOLINE { GALLONS COAL { POUNDS																																
FUEL OIL FILTER ELEMENTS { 1. _____ TYPE _____ 2. _____ TYPE _____																																
GREASE (POUNDS)																																
LUBRICATING OIL (GALLONS) { No. 1 Engine _____ No. 2 Engine _____																																
LUBRICATING OIL (GALLONS) { No. 1 Air Compressor _____ No. 2 Air Compressor _____																																
LUBRICATING OIL FILTER ELEMENTS { 1. _____ TYPE _____ 2. _____ TYPE _____																																
SAND (POUNDS)																																
VALVE OIL (GALLONS)																																

HOURS SINCE LAST SERVICE. Circle hours equipment has operated at time of service. Also circle hours operated last shift previous to service.

REMARKS: _____
FOR INTERNAL COMBUSTION ENGINES ONLY: ENGINE CRANK CASE CAPACITY _____
AIR COMPRESSOR CRANK CASE CAPACITY _____
COOLING SYSTEM CAPACITY _____

W. D., T. C. Form No. 263-114
1944
Copyright © 1944 by the U. S. Railway Administration
This form is to be used only on locomotives and cranes.

SEE REVERSE SIDE FOR REPAIRS

Front.

U. S. A. No.
Station
Month of

Locomotive and Locomotive Crane Maintenance and Inspection Chart

W. D. A. G. O. Form 55-116
COM. P. D. T. C. Form 17
to read and explain see instructions

Non-maintenance and Size, Tone
Homesover
Date Machine Put in Service

Instructions.—The following items are to be checked at the beginning of each shift by the personnel responsible for maintenance of the equipment.

No.	Inspection Item	DAILY OR RECORDED DATA FOR ITEMS INSPECTED																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
1	Fuel supply																																				
2	Water supply																																				
3	Sand supply																																				
4	Drain water from main air reservoir																																				
5	Note excessive air leaks																																				
6	Sanders																																				
7	Horn or whistle																																				
8	Windshield wipers																																				
9	Bell																																				
10	Lights																																				
11	Brake shoes, brake piston travel and brake rigging																																				
12	Instruments and gauges																																				
13	Fire extinguisher																																				
14	Journal boxes—add oil if necessary																																				
15	Engine piping—inspect for leaks and pipe brackets for tightness																																				
16	Note charging rate of battery charging generator																																				
17	Engine performance																																				
18	Oil level, engine crankcase																																				
19	Oil level, air compressor																																				
20	Oil level, motor axle bearings																																				
21	Turn lubricating oil or fuel filter handles two revolutions when so equipped																																				
22	Condition of oil, engine crankcase (Note excess blackness or apparent dilution. Excess oil indicates dilution.)	No. 1																																			
		No. 2																																			
23	Record lubricating oil pressure at idling and full throttle	No. 1																																			
		No. 2																																			
24	Record fuel pressure at idling and full throttle	No. 1																																			
		No. 2																																			
25	Check water level of battery																																				

Figure 18. WD AGO Form 55-116 (Locomotive and Locomotive Crane Maintenance and Inspection Chart).

ALTERATION REPORT FOR STEAM LOCOMOTIVE AND LOCOMOTIVE CRANE BOILERS

The following alterations were made on the boiler of locomotive or locomotive crane No. U. S. A.

....., operated by on
(Unit or Installation)
....., 19....., at

The builder's or assigned number stamped on the dome of this boiler is

NOTE.—Describe below what alterations were made. When blue prints or drawings accompany report, paste same below or on back of report.

STATE OF }
COUNTY OF } ss:

..... being duly sworn says that he inspected the above-mentioned alterations and certifies that the above report is correct.

(Name of affiant)

Subscribed and sworn to before me this day of, 19.....

Adjutant or Notary Public.

The above alterations have caused the following changes in calculated maximum stresses for this boiler.

NOTE.—If stresses are not affected by the alterations, insert the words, "Stresses not changed."

WD AGO Form 55-151
1 February 1945

SEE INSTRUCTIONS ON REVERSE SIDE

Mechanical Engineer.

16-00000-1

Front.

Figure 20. WD AGO Form 55-151 (Alteration Report)

When any repairs or changes are made which affect the data shown on the specification card, a corrected card or an alteration report on an approved form, size 8 x 10½ inches, properly certified to, giving details of such changes shall be filed within 30 days from date of their completion. This report should cover—

- A. Application of new barrel sheets or domes.
- B. Application of patches to barrels or domes of boilers or to portion of wrapper sheet of crown-bar boilers which is not supported by staybolts.
- C. Longitudinal seam reinforcements.
- D. Changes in size or number of braces, giving maximum stress.
- E. Initial application of superheaters, arch or water-bar tubes, giving number and dimensions of tubes.
- F. Changes in number or capacity of safety valves.

Report of patches should be accompanied by a drawing or blue print of the patch, showing its location in regard to the center line of boiler, giving all necessary dimensions and showing the nature and location of the defect. Patches previously applied should be reported the first time the boiler is stripped to permit an examination.

INSTRUCTIONS FOR PREPARING FORM

Describe accurately what alterations were made.

The location and extent of cracks, pitting, corrosion and grooving must be shown and dimensioned unless the defective plate is removed.

Drawing must show whether the plate underneath the patch was removed.

Report must state whether iron or steel rivets were used.

The size of rivet holes must be given as well as the size of the rivets.

If authentic records of the tests of material used in making repairs can be obtained, the lowest tensile strength as shown by test must be given; otherwise 50,000 pounds for steel and 45,000 pounds for wrought iron will be allowed as provided by Rule 4.

It is not necessary to report patches on surfaces supported by staybolts.

All changes in the design of boilers, such as changing from crown bar staying to radial staying, etc., as well as the transfers of boilers, must be shown.

Theater of operation.—The original and one copy of this form must be forwarded to the Railway Grand Division for approval within 30 days after such changes have been made to locomotives or locomotive crane boilers.

Zone of interior.—Completed forms in triplicate are to be furnished the Zone Master Mechanic who will forward original approved copy to the Chief of Transportation, Washington 25, D. C.

U. S. GOVERNMENT PRINTING OFFICE 16-9000-2

Back.

the location and extent of cracks, pitting, corrosion, and grooving will be shown and dimensioned.

(b) The size of rivets and rivet holes will be given and the report state whether iron or steel rivets were used. If authentic records of tests of material used in making repairs are available, the lowest tensile strength as shown by test will be given; otherwise 50,000 pounds for steel and 45,000 pounds for wrought iron will be allowed.

(c) Patches previously applied will be reported the first time the boiler is stripped to permit an examination. It is not necessary to report patches on surfaces supported by staybolts.

(3) Longitudinal seam reinforcements.

(4) Changes in size or number of braces, giving maximum stress.

(5) Initial application of superheaters, arch or water-bar tubes, giving number and dimensions of tubes.

(6) Changes in number or capacity of safety valves.

(7) Initial installations and removals of thermic syphons. Reports filed to cover initial installations will show the number of syphons installed, the construction of the device, the manner of application, and the manner in which the fire box sheets are stayed in the immediate vicinity of the syphons.

(8) Initial installations and removals of low-water alarms. Reports filed to cover initial installations will show the trade name of the device and the manner of application.

210. WD AGO Form 55-152 (Boiler Specification Card for Steam Locomotives and Locomotive Cranes) (fig. 21)

a. A specification card is required for the boiler of each War Department locomotive or locomotive crane and will be prepared and maintained by the chief of transportation in the zone of interior, or by the mechanical engineer, railway grand division headquarters, in theaters of operations. It will contain the results of the calculations made in determining the working pressure and other necessary data, and will be prepared in triplicate from information on builder's specification card accompanying the equipment. One copy will be filed in the office of the chief mechanical officer having charge of the locomotive and two copies will be filed in the office of the mechanical engineer, railway grand division headquarters, theaters of operations, or in the office of the chief of transportation, zone of interior.

b. If the builder's specification card is not available—

(1) The specification card will be filed as promptly

as thorough examination and accurate calculation will permit.

(2) Every specification card will be verified by the oath of the engineer making the calculations and will be approved by the chief mechanical officer.

(3) Where accurate drawings of boilers are available, the date for the specification card may be taken from the drawings. Where accurate drawings are not available, the required data will be obtained at the first opportunity when general repairs are made or when flues are removed.

(4) If the builder's number of boiler is unknown, a number will be assigned to the boiler and the item "Builder's No. of Boiler" on the specification card will be changed to read "Assigned No. of Boiler." This assigned number will also appear in the affidavit. The builder's number of the boiler will be used wherever it is known.

c. Where a boiler is changed from one locomotive to another, such change will be reported promptly, giving the locomotive numbers and boiler numbers involved. When boilers are removed from locomotives, their disposition will be shown. Boiler numbers once recorded on specification cards will not be changed thereafter.

211. WD AGO Form 55-202 (Locomotive Equipment, Supply, and Tool List) (fig. 22)

This form lists locomotive supplies and tools which will be checked, as directed by this form, by maintenance personnel upon arrival at the home terminal after each trip. All the equipment listed will be available on the locomotive and in good working condition.

212. WD AGO Form 55-225 (Weekly Shop Report of Railroad Equipment) (fig. 23)

This form is for indicating progress of repairs to railroad equipment for each week ending at 11:59 pm, Saturday. The report will include data called for on the form and will be based on shop production records. This report will be prepared by railroad equipment repair shops making repairs in excess of second echelon and will be completed in triplicate and one copy retained on file at the shop or installation preparing the report: in the zone of interior, the original and one copy will be sent to the zone master mechanic, who will retain one copy and forward the original to the chief of transportation, Washington 25, D. C. In theaters of operations, the original and one copy will be sent to railway grand division headquarters having jurisdiction over the reporting installation. (WD AGO Form 55-225 supersedes WD AGO Form 55-225, 21 June 1944, and OCT Form

629, 24 July 1944 (Control Approval Symbol No. SPTOR-5).)

213. WD AGO Form 55-226 (Daily Inspection Report for Steam and Other Than Steam Locomotives and Locomotive Cranes) (fig. 24)

This form will be completed by the engineman or crane operator and will be retained on file at the installation where the equipment is operated.

a. Each steam locomotive and tender and other than steam locomotive will be inspected after each trip or day's work and the defects found will be reported on this form.

b. This form will show the number of the locomotive, the place and time of inspection, the defects found, and the signature and occupation of the employee making the inspection.

c. This report requires the approval of the officer in charge. Defects reported, which were not repaired before the locomotive was returned to service, will be explained on the back of the form. When a defect is not repaired, the words "Not Rep. (Over)," will be written on the front of the form; the explanation on the back of the form will be numbered to correspond with the item on the front. The report is then retained on file for future reference at the place where inspection is made.

d. Engineers will inspect their locomotive in accordance with instructions printed on the front of WD AGO Form 55-226.

e. No consideration will be given to verbal reports nor to reports not properly signed by the engineman.

f. Air brake inspectors will report the reservoir and train-line pressures taken when the air pump governor shuts off for full capacity. They will make any necessary adjustments to bring pressure to required minimum and state corrected pressures.

g. In road service the word "trip" means one way over a division or district. On branch or turn-around runs, where one round trip is made in a day, "trip" will be held to mean "round trip". In short branch line service where more than one round trip is made each day, also in yard service, "day's work" instead of "trip" will apply. For locomotives which make one or more round trips per day, with one end of a run terminating at a shop point, daily inspections made at such point will be accepted as meeting the requirements of the rules, even though the day's work is not completed there.

214. Instructions Applicable to Both Monthly and Annual Reports (WD AGO Form 55-227 and WD AGO Form 55-228)

a. **CERTIFICATION OF REPORTS.** (1) Monthly and annual reports will be signed and certified by one or

more inspectors. If one inspector has personal knowledge that all the work shown on the report is performed, he may so certify; otherwise each inspector will sign and indicate before his signature the numbers of the items to which he is certifying.

(2) The officer in charge must have personal knowledge that the work is done properly. If the master mechanic or general foreman has such knowledge, reports signed by him will be accepted; otherwise they must be signed by the officer in charge who has personal knowledge that it is performed properly. When certificates are required as to work performed at outlying points where the officer is unable to be present, the person who performs the work and is responsible for its proper performance, may sign as officer in charge.

(3) Monthly and annual reports will be sworn to before a notary public or adjutant by the inspector or inspectors making the inspection. The officer in charge certifies to the correctness of the reports. An affidavit need not be executed on the reports filed with the mechanical officer in charge in either the zone of the interior or theater of operations.

(4) Before the inspected locomotive is put into service a copy of monthly WD AGO Form 55-227 or annual WD AGO Form 55-228 will be placed in a suitable location in the cab of the locomotive. These reports need not be sworn to, but must in all other ways be a duplicate of the annual report filed with the railway grand division headquarters, or the Chief of Transportation. In the case of the monthly report, it will duplicate the report filed with the zone master mechanic.

b. **PREPARATION OF REPORTS.** In filling out reports, responsible personnel will:

(1) Use typewriter, ink or rubber stamp.

(2) Make sure that reports are sworn to immediately after proper repairs are completed.

(3) Make notation "Corrected Report," on top of any report which is substituted for an incorrect one previously filed; corrected report will be forwarded to the chief mechanical officer.

(4) Do not use such words as "Safe" and "O.K." in answering the items listed in these reports; instead explain the exact condition found.

(5) Answer "Good," "Fair" or "Bad," where the questions require the condition to be shown. Apply the following definitions to these terms:

(*a*) *Good.* That the part or parts have no defects of consequence which could be discovered by a reasonable inspection.

(*b*) *Fair.* That the part or parts have defects, but are in safe and suitable condition and are not in violation of the regulations.

**BOILER SPECIFICATION CARD FOR STEAM LOCOMOTIVES
AND LOCOMOTIVE CRANES**

Date _____, 19____ Locomotive or Locomotive Crane No. U. S. A. _____

Operated by _____
(Unit or installation)

Builder _____
 Builder's No. of boiler _____
 When built _____
 Where built _____
 Type of boiler _____
 Material of boiler shell sheets _____
 Material of rivets _____
 Dome, where located _____
 Grate area in sq. ft. _____
 Height of lowest reading of gauge glass above crown sheet _____
 Height of lowest gauge cock above crown sheet _____
 Water bar tubes, O. diam. _____
 thickness _____
 Arch tubes, O. diam. _____
 thickness _____
 Fire tubes, number _____
 Fire tubes, O. diam. _____
 length _____
 Safety valves—
 No. Size Make Style

 Firebox stay bolts, O. diam. _____, spaced _____
 Combustion chamber stay bolts, O. diam. _____
 Combustion chamber stay bolts, spaced _____
 Crown stays, O. diam., top _____, bottom _____
 Crown stays, spaced _____
 Crown bar rivets, O. diam., top _____, bottom _____
 Crown bar rivets, spaced _____
 Water space at firebox ring, sides _____
 back _____, front _____
 Width of water space at sides of firebox measured at center line of boiler, front _____
 back _____

Shell sheets—
 Front tube _____ thick. _____ I. diam.
 1st course _____ " _____ " _____
 2d " _____ " _____ " _____
 3d " _____ " _____ " _____
 4th " _____ " _____ " _____
Mem.—When courses are not cylindrical give inside diameter at each end.
 Firebox—
 Thickness of sheets—
 Tube _____ Crown _____ Side _____
 Door _____ Combustion chamber _____
 Inside throat (if tube sheet is in two pieces) _____
 External firebox—
 Thickness of sheets—
 Throat _____ Back head _____
 Roof _____ Sides _____
 Dome, inside diam. _____
 Thickness of sheet _____ Base _____ Liner _____
 Were you furnished with authentic records of the tests of materials used in boiler? _____
 Records on file in the office of the _____ of the _____ Company show that the lowest tensile strength of the sheets in the shell of this boiler is—
 1st course _____ pounds per sq. in.
 2d " _____ " _____ " _____
 3d " _____ " _____ " _____
 4th " _____ " _____ " _____
 Dome _____ " _____ " _____
 Dome liner _____ " _____ " _____
Mem.—When courses are not cylindrical give inside diameter at each end.
 Is boiler shell circular at all points? _____
 If shell is flattened, state location and amount _____
 Are all parts thoroughly stayed? _____
 Are dome and other openings sufficiently reinforced? _____
 Is boiler equipped with fusible plugs? _____

Make working sketch here or attach drawing of longitudinal and circumferential seams used in shell of boiler, indicating on which courses used, and give calculated efficiency of weakest longitudinal seam.

Front.

Figure 21. WD AGO Form 55-152 (Boiler Specification

Stay bolts—Form of threads { Crown _____
 Water space _____

The maximum stresses at the allowed working pressure were found by calculation to be as follows:

Stay bolts at root of thread _____ lb. per sq. in.	Round and rectangular braces _____ lb. per sq. in.
Stay bolts at reduced section _____ lb. per sq. in.	Gusset braces _____ lb. per sq. in.
Crown stays or crown-bar rivets at root of thread or smallest section, top _____ lb. per sq. in.	Shearing stress on rivets _____ lb. per sq. in.
Crown stays or crown-bar rivets at root of thread or smallest section, bottom _____ lb. per sq. in.	Tension on net section of plate in longitudinal seam of lowest efficiency, pounds per sq. in. _____

Dimensions and data taken from locomotive were furnished by _____

Data upon which above calculations were made were obtained from drawing No. _____
 dated _____, furnished by _____ Company.

Mechanical Engineer.

STATE OF _____
 COUNTY OF _____ ss:

_____ being duly sworn, says that he is the officer who signed the foregoing specification, that he has satisfied himself of the correctness of the drawings and data used, has verified all of the calculations, and has examined the record of present condition of boiler dated _____ and sworn to by inspector _____ and believes that the design, construction, and condition of boiler No. _____ renders it safe for a working pressure of _____ pounds per square inch.

Mechanical Engineer (Affiant).

Subscribed and sworn to before me }
 this _____ day of _____, 194_____ }

Adjutant or Notary Public.

APPROVED:

Back.

LOCOMOTIVE EQUIPMENT, SUPPLY AND TOOL LIST	INSTRUCTIONS	
<p>1. SIGNAL EQUIPMENT</p> <ul style="list-style-type: none"> 2 WHITE FLAGS 2 RED FLAGS 2 GREEN FLAGS 12 FUSES 24 TORPEDOES 2 CLASSIFICATION LAMPS 1 WHITE OIL-BURNING LANTERN COMPLETE 1 RED OIL-BURNING LANTERN COMPLETE <p>2. EMERGENCY EQUIPMENT</p> <ul style="list-style-type: none"> 1 EMERGENCY KNUCKLE 1 CHAIN, CAR, WRECKING 1 PUSH POLE 1 SET OAKWOOD BLOCKS FOR DRIVING BOXES 1 SET WOOD BLOCKING FOR CROSS HEAD AND VALVE GEAR 1 TENDER TRUCK JOURNAL BEARING 1 ENGINE TRUCK JOURNAL BEARING 1 FROG, WRECKING, RAILROAD, CAR AND LOCOMOTIVE, DOUBLE END, INSIDE, FOR RAIL UP TO 8" HIGH 1 FROG, WRECKING, RAILROAD, CAR AND LOCOMOTIVE, DOUBLE END, OUTSIDE, FOR RAIL UP TO 8" HIGH 1 AIR HOSE 6 AIR NOSE GASKETS 1 EXTRA WATER GAGE GLASS 2 EXTRA WATER GAGE GASKETS 1 15-TON JOURNAL JACK WITH LEVER <p>3. HOT BOX EQUIPMENT & SUPPLIES</p> <ul style="list-style-type: none"> 1 KNIFE, PACKING, RAILROAD CAR JOURNAL BOX 1 HOOK, RAILROAD CAR, PACKING 3 LB. ROD CUP GREASE <p>4. OIL EQUIPMENT & SUPPLIES</p> <ul style="list-style-type: none"> 2 GAL. VALVE OIL 2 GAL. CAR OIL 4 GAL. KEROSENE 1 TALLOW POT, 5 PT. 2 1-QT. HAND OILERS, LONG SPOUT 1 TORCH, HAND, ENGINEER, 1-PT. 	<p>1. Equipment, supplies and tools will be checked by maintenance personnel on road locomotives upon arrival at home terminal each trip. Missing or defective equipment, supplies or tools will be listed and reported to roundhouse foreman, who will initiate requisition for replacement.</p> <p>2. Enginemen will be accountable for proper care of equipment, supplies and tools while in their charge and will make report upon arrival at home terminal to the roundhouse foreman, listing any shortages, or defective tools or equipment requiring replacement.</p> <p>3. A copy of this form will be posted in a suitable frame in the cab of each locomotive.</p> <p>5. EXTRA EQUIPMENT</p> <ul style="list-style-type: none"> 1 BROOM 1 WATER BUCKET, 14-QT. 1 EXTRA LANTERN FOUNT, COMPLETE WITH BURNER AND WICK 1 RED LANTERN GLOBE 1 WHITE LANTERN GLOBE 1 SPARE HEADLIGHT GLOBE 2 SPARE CAB GLOBES 1 WATER COOLER WITH JUG <p>6. TOOLS</p> <ul style="list-style-type: none"> 1 7/8"x1" OPEN END WRENCH, "S" TYPE" 1 1 1/8"x1 1/4" OPEN WRENCH, "S" TYPE" 1 12-INCH MONKEY WRENCH 1 18-INCH ADJUSTABLE PIPE WRENCH 1 GREASE CUP WRENCH OR GUN 1 COLD CHISEL - 3/4"x8" 1 HAMMER, MACHINIST, BALL PEIN, 2-LB. 1 BAR, LOCOMOTIVE, PINCH, 5' 1 HOOK, WATER SPOUT, 5 FT. 1 10-LB. SLEDGE WITH HANDLE <p>7. FIRE TOOLS</p> <ul style="list-style-type: none"> 1 SCOOP SHOVEL, COAL NO. 2 1 COAL PICK 1 RAKE, LOCOMOTIVE FIRE BOX 1 POKER, LOCOMOTIVE FIRE BOX 9 FT. 1 GRATE SHAKER BAR 1 CHISEL BAR 1 1/8"x4 FT. 	
<p>WD AGO FORM 55-202 1 February 1945</p>	<p>This form supersedes WD TC MRS Form Notice No. 9, undated, which may be used until existing stocks are exhausted.</p>	<p>55-2022-01</p>

Figure 22. WD AGO Form 55-202 (Locomotive Equipment, Supply and Tool List).

DAILY INSPECTION REPORT LOCOMOTIVES AND LOCOMOTIVE CRANES		LOCOMOTIVE OR LOCOMOTIVE CRANE NO. USA-	TRAIN NUMBER
		LOCATION	TIME AND DATE
<p><small>Each locomotive and tender must be inspected after each trip or day's work and report made on this form, whether it needs repairs or not. Proper explanation must be made hereon for failure to repair any defects reported, and the form approved by Foreman, before locomotive is returned to service.</small></p>			
WORK ITEM	REPAIRS NEEDED (Reported by Engineman)	SIGNATURE OF PERSONS COMPLETING WORK OR FOREMAN'S REASON FOR NOT DOING WORK	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
CONDITION OF			
INJECTORS	SAFETY VALVES LIFT AT	MILEAGE	BELTS
WATER COLUMN	SAFETY VALVES SEAT AT	FUEL SYSTEM	SIGNATURE OF ENGINEMAN
WATER GLASS	BRAKE EQUIPMENT	LUBRICATING SYSTEM	
GAUGE COCKS	MAIN RESERVOIR PRESSURE	COOLING SYSTEM	
HOURS ON DUTY	BRAKE PIPE PRESSURE	BATTERY	
WORK ITEM	REPAIRS NEEDED (Reported by Inspector)	SIGNATURE OF PERSONS COMPLETING WORK OR FOREMAN'S REASON FOR NOT DOING WORK	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
INSPECTOR		INSPECTOR	
SIGNATURE OF OFFICER-IN-CHARGE (The above work has been performed except as noted and report is approved)			
NOTE: Proper explanation should be made on back of this form for failure to repair any items reported.			
<small>WD AGO FORM 55-226 This form supersedes WD AGO 55-226, 22 July 1944, WD MRS 502, 1 March 1944, WD AGO 55-114, undated, and WD TC 263, 17 April 1944, which may be used until existing stocks are exhausted.</small>			

Figure 24. WD AGO Form 55-226 (Daily Inspection Report, Locomotives and Locomotive Cranes).

(c) *Bad.* That the part or parts are *not* in a safe or suitable condition or, are in violation of regulations.

c. TIME OF FILING. (1) No monthly report, WD AGO Form 55-227, will be required for the month in which an annual report, WD AGO Form 55-228 is made.

(2) The monthly inspection will be made every calendar month and the period between inspections will not materially exceed 30 days. Where an inspection is made on the first of a month having 31 days, another inspection is not required until the first day of the immediately following month.

(3) All reports in theaters of operations will be filed with the railway grand division headquarters within 15 days after date of inspection.

(4) In the zone of interior, reports will be filed within 15 days after date of inspection. The annual report will be forwarded to the chief of transportation. The monthly report will be sent to the zone of transportation officer, Attention: the zone master mechanic.

d. OUT OF SERVICE REPORTS. (1) The number of days that a locomotive is out of service will be noted on WD AGO Form 55-228. For example, the notation "locomotive out of service undergoing repairs from 10 September to 25 September" would inform all concerned as to the reason for the extension of the dates between inspections. No postponement, however, is permitted of the next inspection date. An inspection will be made and a report filed for each calendar month that a locomotive is in service.

(2) Out of service reports may be filed for locomotives which are out of service for an entire calendar month, or, are out of service when due for inspection and remain out of service for the balance of the month. A copy of the out of service report will be placed in the cab card holder on the locomotive.

(3) When an out of service report is filed, an inspection will be made and a report filed before the locomotive is again returned to service.

(4) Out of service reports will not be filed until the end of the month wherein the duration of non-service occurred.

(5) Out of service reports need not be sworn to, but will be signed by the mechanical officer in charge.

(6) The time out of service will be properly covered by out of service reports, and a notation as to the months out of service will be made on the back of inspection reports and cab cards.

(7) When a locomotive is permanently retired from service because it is condemned, scrapped, or

sold, a final report will be made on WD AGO Form 55-228. This report will show the locomotive number and the boiler number and will be filed as follows:

(a) In theaters of operations, the form will be filed with the railway grand division headquarters under whose jurisdiction the locomotive last operated.

(b) In the zone of interior, the form will be forwarded to the chief of transportation. A copy will be filed at the station where the locomotive last operated.

(c) The mechanical officer in charge at station where locomotive is dismantled must certify to and arrange for forwarding of the final report.

(d) Disposition of locomotive will be shown on the form.

(e) When an entire locomotive is condemned, scrapped, or sold, filing of this final report will close the record for that locomotive and further reports need not be filed.

(8) When the boiler only is scrapped or otherwise disposed of and the locomotive is continued in service with a new or other boiler, the report will be filed as follows:

(a) If the locomotive is returned to service with the new or other boiler, the WD AGO Form 55-228 filed at that time will have a notation on the back explaining the replacement of the original boiler by another. The numbers of both boilers involved will be given; if the boiler is not new, the number of the locomotive from which the replacement boiler was obtained, will be indicated.

(b) If the boiler is removed from a locomotive and held as a spare for future use, it will be reported and certified on WD AGO Form 55-228. It will be marked "Spare Boiler Report," and will be filed in the same manner as outlined above for the final report.

(c) Spare Boiler Reports will be stamped or typed diagonally on WD AGO Form 55-228 as follows:

SPARE BOILER REPORT
LOCOMOTIVE BOILER NO.
REMOVED FROM LOCOMOTIVE _____ AT _____
(Number) (Station)

HELD AS SPARE
AND WILL NOT BE USED IN LOCOMOTIVE SERVICE UNTIL INSPECTION REPORT IS FILED.
DATE _____ 19____

215. WD AGO Form 55-227 (Monthly Inspection and Repair Report for Steam Locomotives and Locomotive Cranes) (fig. 25)

a. GENERAL. (1) This report will be completed monthly in triplicate by the inspector and counter-

MONTHLY INSPECTION AND REPAIR REPORT

Steam Locomotives and Locomotive Cranes

Locomotive { No. _____
Initial, U. S. A. _____

In accordance with the act of Congress approved February 17, 1911, as amended March 4, 1915, and the rules and instructions issued in pursuance thereof and approved by the Interstate Commerce Commission, all parts of Locomotive No. _____, including the boiler and appurtenances, were inspected on _____, 19____, at _____ and all defects disclosed by said inspection have been repaired, except as noted on the back of this report.

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Steam gauges tested and left in good condition on _____, 19_____ 2. Safety valves set to pop at _____ pounds, _____ pounds, _____ pounds on _____, 19_____ 3. Were both injectors tested and left in good condition? _____ 4. Were steam leaks repaired? _____ 5. Condition of brake and signal equipment _____ 6. Condition of draft gear and draw gear _____ 7. Condition of driving gear _____ 8. Condition of running gear _____ 9. Condition of tender _____ 9a. Was interior of tender tank cleaned and washed? _____ | <ol style="list-style-type: none"> 10. Was boiler washed and were gage cocks and water glass cock spindles removed and cocks cleaned? _____ 11. Were steam leaks repaired? _____ 12. Condition of staybolts and crown stays _____ 13. Number of staybolts and crown stays renewed _____ 14. Condition of flues and fire-box sheets _____ 15. Condition of arch and water bar tubes, if used _____ 16. Were fusible plugs removed and cleaned? _____ 17. Date of previous hydrostatic test _____, 19_____ 18. Date of removal of caps from flexible staybolts _____, 19_____ |
|---|--|

I certify that the above report is correct.

I certify that the above report is correct.

Inspector.

Inspector.

Inspector.

Inspector.

STATE OF _____ }
COUNTY OF _____ } ss:

Subscribed and sworn to before me this _____ day of _____, 19____, by _____
inspectors of the _____

The above work has been performed and the report is approved.

Adjutant or Notary Public.

WD AGO Form 55-227
1 December 1944
This form supersedes WD AGO Form 55-227, 12 June 1944 (Old TC MRS Form 503, 12 May 1944), WD AGO Form 55-117, 8 August 1944 (Old TC Form 266, 17 April 1944), and WD TC Form 268, 17 April 1944, which may be used until existing stocks are exhausted.

Officer in Charge.

16-43000-1

Front.

LOCOMOTIVE OUT OF SERVICE RECORD												
YEAR	FULL CALENDAR MONTH OUT OF SERVICE											
	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	Nov.	Dec.
19												
19												
19												
19												
19												
19												

U. S. GOVERNMENT PRINTING OFFICE 16-43000-1

Back (Locomotive out of Service Record).

Figure 25. WD AGO Form 55-227 (Monthly Inspection and Repair Report, Steam Locomotives and Locomotive Cranes)

signed by the person in charge of maintaining the equipment. One copy will be placed in a suitable location in the cab of the locomotive; one copy will be retained on file at the installation, and one copy, if in the zone of the interior, forwarded to the zone transportation officer, Attention: the zone master mechanic, or, if in a theater of operations, to the railway grand division headquarters under whose jurisdiction the locomotive last operated.

(2) The month and year for which the report is filed will be inserted in the upper left hand corner of the report, and the number of the locomotive will appear in the upper right hand corner. The locomotive number will be placed on line 2 of the body of report and will correspond with that given in the upper right hand corner. The date will appear on line 2 and the place of the inspection and subsequent repair work will appear on line 3 of the body of the report. The date refers to the day on which repairs were completed.

b. SPECIFIC INSTRUCTIONS. In the preparation of the monthly inspection and repair report form, responsible personnel will:

(1) Under Item 1, show the date on which steam gauges were tested and left in good condition. Steam gauges will be tested immediately before safety valves are set or any changes are made in the setting.

(2) Under Item 2, show the pressure at which each safety valve is set to open. If the locomotive is equipped with only two safety valves, insert the word "None" in the space on the report for the third safety valve. The date of the setting will be noted.

(3) Under Item 3, answer "Yes" or "No". When locomotive is equipped with one injector and one feed water pump instead of two injectors, place an asterisk (*) opposite Item 3 with a notation below the affidavit or on the margin of the report, as follows: "(*) One Injector and One Feed Water Pump." The answer to these questions will then include the condition of both injector and feed water pump, the same as if two injectors were used.

(4) Under Item 4, answer "Yes" or "No." (*Note.* This question refers to all steam leaks other than those existing in the boiler proper).

(5) Under Item 5, give two answers: First, show condition of brake equipment; second, show condition of signal equipment. If signal equipment is not used, answer "Not used."

(6) Under Item 6, give two answers: First indicate condition of draft gear; second, show condition of drawgear. In addition to the two answers required, show the month in which the drawbar and pins are removed and inspected by the following notation: "R. & I—(Date)."

(7) Under Item 7, show condition of driving gear.

(8) Under Item 8, show condition of running gear.

(9) Under Item 9, show condition of tender. Answer "Not used," when locomotives have saddle tanks or side tanks and no tender. (*Note.* This answer will cover all parts of the tender not included in Items 5, 6 and 8.)

(10) Under Item 10, give two answers, each of which will be "Yes" or "No".

(11) Under Item 11, answer "Yes" or "No". (*Note.* This item refers to all steam leaks existing in the boiler proper).

(12) Under Item 12, give two answers: First, show condition of staybolts; second, show condition of crown stays.

(13) Under Item 13, give two answers: First, show number of staybolts renewed; second, show number of crown stays renewed.

(14) Under Item 14, give two answers: First, show condition of flues; second show condition of firebox sheets.

(15) Under Item 15, give two answers: First, show condition of arch tubes; second, show condition of water bar tubes. If either are not used, the answer will be "Not used."

(*a*) Where a firebox is equipped with syphons or circulators instead of arch tubes, or where these are used with arch tubes, place an asterisk (*) opposite Item 15, with the notation "(*) (Give number) syphons, or circulators."

(*b*) Show also the condition of the syphons or circulators, when any of the above combinations are used in the same firebox.

(16) Under Item 16, give two answers, "Yes" or "No" or "Renewed". If not used, answer "Not used". When the boiler is equipped with a low water alarm, place an asterisk (*) opposite Item 16 with a notation below the affidavit or on the margin of the report; "(*) (Give name) low water alarm."

(17) Under Item 17, give date of the previous hydrostatic test.

(18) Under Item 18, give the date of removal of caps from flexible staybolts. If locomotive is not equipped with flexible staybolts having caps, answer "Not used."

(*a*) When all flexible staybolts of a boiler are provided with telltale holes and are tested with an approved electrical or other instrument in accordance with rule No. 16 (2), show the last date on which the telltale holes were opened and tested. For example: Item 18. (Date of Removal of Caps from Flexible Staybolts" 16 (2) 1 February 1945.

(*b*) When the boiler is equipped with flexible stay-

bolts having caps over the outer ends and with some of the staybolts having no telltale holes, show the date of the previous removal of caps from staybolts without telltale holes. Also give the date on which the staybolts with telltale holes were opened and tested with an approved electrical or other instrument. For example: Item 18. "Date of Removal of Caps from Flexible Staybolts"—Caps Removed 1 February 1944; 16 (2), 1 February 1945.

(c) In the above cases where rule No. 16 (b) is complied with, an asterisk (*) will be placed opposite Item 18 with a notation below the affidavit or on the margin of report: "(*) 18-Rule 16 (2) complied with (Give color of porous plug) applied."

216. WD AGO Form 55-228 (Annual Inspection and Repair Report for Steam Locomotives and Locomotive Cranes) (fig. 26)

a. GENERAL. (1) This report will be prepared annually in quadruplicate by the inspector and countersigned by the person in charge of maintaining the equipment. One copy will be posted in the cab of the locomotive or locomotive crane in a suitable place under glass to prevent deterioration; one copy will be retained on file at the installation; and, in the zone of interior, two copies forwarded to the zone master mechanic who will forward one copy to the chief of transportation, or in the theaters of operations, two copies to the railway grand division headquarters under whose jurisdiction the locomotive last operated.

(2) The month and year for which the report is filed will be inserted in the upper left hand corner of the report, and the number of the locomotive will be placed in the upper right hand corner. The locomotive number will appear on line 2 of the body of the report and will correspond with that given in the upper right hand corner. The date and place of the inspection and repairs will be given on line 3. By date is meant the day on which repairs were completed.

b. SPECIFIC INSTRUCTIONS. In the preparation of the annual inspection and repair report, responsible personnel will:

(1) Under Item 1, give date of the previous hydrostatic test.

(2) Under Item 2, give the date of the previous removal of caps from flexible staybolts. If the locomotive is not equipped with flexible staybolts having caps, the answer will be "Not used".

(a) When all flexible staybolts of a boiler are provided with telltale holes and are tested with an approved electrical or other instrument in accordance with rule No. 16 (2), show the last date on which the

telltale holes were opened and tested. For example: Item 2, "Date of Previous Removal of Caps from Flexible Staybolts"—16 (2), 1 February 1945.

(b) If the boiler is equipped with flexible staybolts having caps over the outer ends and with some of the staybolts having no telltale holes, show the date of previous removal of caps from staybolts without telltale holes. Also give the date on which the staybolts with telltale holes were opened and tested with approved electrical or other instrument. For example: Item 2. "Date of Previous Removal of Caps from Flexible Staybolts"—Caps Removed 1 February 1944. 16 (2) 1 February 1945.

(3) Under Item 3, give the date of the previous removal of all flues.

(4) Under Item 4, give the date of the previous removal of all lagging from the boiler.

(5) Under Item 5, show the pressure applied when hydrostatic test was given.

(6) Under Item 6, answer "Yes" or "No". If flexible staybolts are not used, the question will be answered "Not used".

(a) When all flexible staybolts of a boiler are provided with telltale holes and are tested with an approved electrical or other instrument in accordance with rule No. 16 (2) answer this item as follows: Item 6. "Were Caps Removed from all Flexible Staybolts"—16 (2).

(b) When the caps are removed from flexible staybolts without telltale holes, and the bolts which are provided with telltale holes are tested per rule No. 16 (2), answer this item as follows: Item 6: "Were Caps Removed from all Flexible Staybolts" "Yes"—16 (2).

(c) When the caps are not removed from the flexible staybolts without telltale holes, and the staybolts which are provided with telltale holes, are tested, per rule No. 16 (2) answer the form as follows: Item 6. "Were Caps Removed from all Flexible Staybolts"—"No"—16 (2).

(d) In the above cases where rule No. 16 (2) is complied with, place an asterisk (*) opposite Item 6 with notation below the affidavit or on the margin of the report, "(*) 6—rule No. 16 (2) complied with (give color of porous plug) applied."

(7) Under Item 6-A, answer "Yes" or "No".

(8) Under Item 7, give two answers: First, "Yes" or "No"; second, give the number of flues removed. If the small flues of the locomotive are removed and it is equipped with superheater flues, answer the first question as follows: "Yes, except superheater flues." This notation may be made on the margin of the report.

**ANNUAL INSPECTION AND REPAIR REPORT
STEAM LOCOMOTIVES AND LOCOMOTIVE CRANES**

Locomotive
or
Locomotive
Crane
Number USA _____

In accordance with the act of Congress approved February 17, 1911, as amended March 4, 1915, and the rules and instructions issued in pursuance thereof and approved by the Interstate Commerce Commission, all parts of locomotive No. _____, including the boiler and its appurtenances, were inspected on _____, 19____, at _____ and all defects disclosed by said inspection have been repaired, except as noted on the back of this report.

- | | |
|---|---|
| <p>1. Date of previous hydrostatic test _____, 19____</p> <p>2. Date of previous removal of caps from flexible staybolts _____, 19____</p> <p>3. Date of previous removal of flues _____, 19____</p> <p>4. Date of previous removal of all lagging _____, 19____</p> <p>5. Hydrostatic test pressure of _____ pounds was applied.</p> <p>6. Were caps removed from all flexible stay bolts? _____</p> <p>7. Were all flues removed? _____ Number removed _____</p> <p>8. Condition of interior of barrel _____</p> <p>9. Was all lagging removed? _____</p> <p>10. Condition of exterior of barrel _____</p> <p>11. Was boiler entered and inspected? _____</p> | <p>12. Was boiler washed? Water glass cocks and gage cocks cleaned? _____</p> <p>13. Condition of crown stays and stay bolts _____</p> <p>14. Condition of sling stays and crown bars _____</p> <p>15. Condition of firebox sheets and flues _____</p> <p>16. Condition of arch tubes _____ Water bar tubes _____</p> <p>17. Condition of throat braces _____</p> <p>18. Condition of back head braces _____</p> <p>19. Condition of front flue sheet braces _____</p> <p>20. Were fusible plugs removed and cleaned? _____</p> <p>21. Were steam leaks repaired? _____</p> |
|---|---|

I CERTIFY that the above report is correct. _____, *Inspector.*

- | | |
|---|--|
| <p>22. Were steam gages tested and left in good condition? _____</p> <p>23. Safety valves set to pop at _____ pounds, _____ pounds, _____ pounds.</p> <p>24. Were both injectors tested and left in good condition? _____</p> <p>25. Were steam leaks repaired? _____</p> <p>26. Hydrostatic test of _____ pounds applied to main reservoirs.</p> | <p>27. Condition of brake and signal equipment _____</p> <p>28. Were drawbar and drawbar pins removed and inspected? _____</p> <p>29. Condition of draft gear and draw gear _____</p> <p>30. Condition of driving gear _____</p> <p>31. Condition of running gear _____</p> <p>32. Condition of tender _____</p> |
|---|--|

32a. Was interior of tender tank cleaned and washed? _____
I CERTIFY that the above report is correct. _____, *Inspector.*

I CERTIFY that the above work has been performed and the report is approved.

_____, *Officer in Charge.*

_____, *Adjutant.*

WD AGO FORM 55-228
1 MAR 1945

This form supersedes WD AGO Form 55-228, 1 January 1945, WD AGO Form 228, undated, (old WD TC MRS Form 504, undated) and that part of AGO Form 417, 21 June 1944, pertaining to locomotive cranes.

Front.

LOCOMOTIVE OUT OF SERVICE

Month Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
19												
19												
19												
19												
19												
19												
19												

Back.

Figure 26. WD AGO Form 55-228 (Annual Inspection and Repair Report, Steam Locomotives and Locomotive Cranes).

(9) Under Item 8, give the condition of the interior of the boiler if all flues are removed or if a sufficient number of flues are removed to allow a thorough examination. If such a number of flues are not removed, but the interior of the barrel above the flues is examined, show its condition. For example, "Good above flues."

(10) Under Item 9, answer "Yes" or "No".

(11) Under Item 10, give the condition of the exterior of the boiler if sufficient lagging is removed to permit a thorough inspection. If not, answer this item, "Not inspected". (*Note.* This inspection will be made while boiler is under pressure.)

(12) Under Item 11, answer "Yes" or "No".

(13) Under Item 12, give two answers, each of which will be answered "Yes" or "No".

(14) Under Item 13, give two answers: First, show condition of crownstays; second, show condition of staybolts.

(15) Under Item 14, give two answers: First, show condition of sling stays; second, show condition of crown bars as far as can be inspected.

Note. If the boiler is not equipped with either sling stays or crown bars, the answer to each question will be "Not used."

(16) Under Item 15, give two answers: First, show condition of firebox sheets; second, show condition of flues.

(17) Under Item 16, give two answers: First, show condition of arch tubes; second, show condition of water bar tubes.

Note. When arch tubes or water bar tubes are not used, the answer in either case will be "Not used."

(a) Where a firebox is equipped with syphons or circulators without arch tubes, or syphons or circulators with arch tubes, place an asterisk (*) opposite Item 16 with notation on the margin of the report: "(*) (Give number) Syphons or Circulators."

(b) In case (17) (a) above is true, answer the question by showing the condition of the syphons, circulators, arch tubes or arch tubes and syphons, or arch tubes and circulators, when any of the above combinations are used in same firebox.

(18) Under Item 17, give the condition of throat braces if inspected. If they cannot be inspected, the answer will be "Not inspected."

(19) Under Item 18, give the condition of back head braces whenever it is possible for these braces to be inspected. If not inspected, the answer will be "Not inspected."

(20) Under Item 19, give the condition of the front flue sheet braces whenever it is possible for these braces to be inspected; if not inspected, answer "Not inspected."

(21) Under Item 20, if boiler is equipped with fusible plugs answer "Yes" or "No" (Renewed). (*Note.* If boiler is not equipped with fusible plugs, the answer will be "Not used.") When a low water alarm is applied place an asterisk (*) opposite Item 20 with notation: "(*) (Give name) Low Water Alarm, (Condition)". If the report does not bear the notation "Low Water Alarm," it will indicate that a "Low Water Alarm" is not applied.

(22) Under Item 21, answer "Yes" or "No". (*Note.* This question refers to all steam leaks existing in the boiler proper.)

(23) Under Item 22, answer "Yes" or "No".

(24) Under Item 23, show the pressure at which each safety valve is set to open. If the locomotive is equipped with only two safety valves, insert in the space for the third safety valve the word "None."

(25) Under Item 24, answer "Yes" or "No". When the locomotive is equipped with one injector and one feed water pump instead of two injectors, place an asterisk (*) opposite item 24 with a notation below the affidavit or on the margin of the report as follows: "(*) One Injector and One Feed Water Pump". In answer to the question, include the condition of both the injector and the feed water pump the same as if two injectors were used.

(26) Under Item 25, answer "Yes" or "No". (*Note.* This item refers to all steam leaks other than those existing in boiler proper.)

(27) Under Item 26, show the pressure given to main reservoirs when hydrostatic tests were applied.

(28) Under Item 27, give two answers: First, show condition of the brake equipment; second, show condition of the signal equipment. If signal equipment is not used, the answer will be "Not used."

(29) Under Item 28, answer "Yes" or "No".

(30) Under Item 29, give two answers: First, show the condition of draftgear; second, show the condition of drawgear.

(31) Under Item 30, show the condition of driving gear.

(32) Under Item 31, show the condition of running gear.

(33) Under Item 32, show the condition of tender. (*Note.* This item includes all parts of tender not covered in Items 27, 28, 29 and 31.)

217. WD AGO Form 55-230 (Monthly Inspection and Repair Report for Locomotives and Locomotive Cranes Other Than Steam) (fig. 27)

This record will be prepared and distributed in the same manner as WD AGO Form 55-227 (Monthly Inspection and Repair Report for Steam Locomotives and Locomotive Cranes).

**MONTHLY INSPECTION AND REPAIR REPORT OF LOCOMOTIVES AND
LOCOMOTIVE CRANES OTHER THAN STEAM**

Locomotive { No. _____
 { Initials U. S. A. _____

_____, 19____
Operated by _____

In accordance with the act of Congress approved February 17, 1911, amended March 4, 1915, and June 7, 1924, and the rules and instructions issued in pursuance thereof, the parts and appurtenances of locomotive unit No. _____ were inspected on _____, 19____ at _____ All defects disclosed by said inspection were properly repaired, except as noted on the reverse side of this report and the parts and appurtenances were left in the condition reported below.

1. This locomotive unit is propelled by _____
2. Hydrostatic test of _____ pounds was applied to main air reservoirs.
Date of previous test as shown by reports on file was _____
3. Were main air reservoirs hammer tested? _____
Date of previous test as shown by reports on file was _____
4. Were drawbars and pins removed and inspected? _____
Date of previous removal as shown by stamping on the parts _____
5. Were articulated connection pins removed and inspected? _____
Date of previous removal as shown by stamping on the pins _____
6. Condition of draft gear and draw gear is _____
7. Condition of brake and signal equipment is _____
8. Condition of running gear is _____
9. Condition of fuel storage and supply system is _____

10. Date of previous insulation tests as shown by reports on file was _____
19____
Were insulation tests applied at this inspection? _____

Name of circuit	Normal voltage	Test voltage
_____	_____	_____
_____	_____	_____

11. Condition of current collectors is _____
12. Condition of control equipment is _____
13. Condition of control circuits and terminals is _____
14. Condition of power equipment is _____
15. Condition of power circuits and terminals is _____
16. Condition of lightning arresters is _____
17. Were meters tested? _____ Date meters were previously tested as shown by reports on file was _____, 19____

I certify that I made the inspections and tests above reported in Items No. _____ and that statements therein are true and correct.

I certify that I made the inspections and tests above reported in Items No. _____ and that statements therein are true and correct.

I certify that I made the inspections and tests above reported in Items No. _____ and that statements therein are true and correct.

I certify that I made the inspections and tests above reported in Items No. _____ and that statements therein are true and correct.

The above work has been performed under my general supervision and I believe the report is true and correct.

_____, *Officer in Charge.*

WD AGO Form 55-230-1 December 1944
This form supersedes WD AGO Form 55-230, 21 June 1944 (Old TO Form 506, undated),
WD TO Form 267, 17 April 1944, and WD AGO Form 55-130, 8 August 1944 (Old TO Form
260, 17 April 1944), which may be used until existing stocks are exhausted.

Front.

Note defects not properly repaired:

Unit No. _____ was out of service the entire calendar months of:

State of _____ } ss:
County of _____ }

On this _____ day of _____, 19____, personally appeared before me _____ and signed the reverse side of this report, each of whom deposes and says that he personally made the inspections and tests reported in items the numbers of which precede his signature, and that the statements therein are true and correct.

Subscribed and sworn to before me according to law this _____ day of _____, 19____

State of _____ } ss:
County of _____ }

_____, *Notary Public.*
Adjutant or

On this _____ day of _____, 19____; personally appeared before me _____ and signed the reverse side of this report as *officer in charge*, who deposes and says that the inspections and tests reported were made under his general supervision, and that he believes the report is true and correct.

Subscribed and sworn to before me according to law this _____ day of _____, 19____

_____, *Notary Public.*
Adjutant or

U. S. GOVERNMENT PRINTING OFFICE 16-42120-1

Back.

Figure 27. WD AGO Form 55-230 (Monthly Inspection and Repair Report of Locomotives and Locomotive Cranes Other than Steam.)

be entered in the proper columns and in accordance with the test period specified on this form.

220. WD AGO Form 55-236 (Steam and Internal Combustion Locomotive Specification Card) (fig. 30)

This will be completed in duplicate by the person in charge of maintaining the equipment. One copy will be retained on file at the installation where the equipment is operated and one copy will be forwarded to the railway grand division headquarters in theaters of operations, or to the zone transportation officer, Attention: the zone master mechanic, in the zone of interior. This report is filed annually or when changes occur making an additional report necessary.

221. WD AGO Form 55-239 (Report of Broken Staybolts) (fig. 31)

This will be prepared monthly in duplicate by the person in charge of maintaining the equipment. One copy will be retained on file at the installation where the equipment is operated and one copy will be forwarded to the railway grand division headquarters in theaters of operations, or to the zone transportation officer, Attention: the zone master mechanic, in the zone of interior.

222. WD AGO Form 55-240 (Monthly Report of Condition of Locomotives) (fig. 32)

This form will be prepared monthly in duplicate by the person in charge of maintaining the equipment. One copy will be retained on file at the installation where the equipment is operated and one copy will be forwarded to the railway grand division headquarters in theaters of operation, or to the zone transportation officer, Attention: the zone master mechanic, in the zone of interior.

223. WD AGO Form 468 (War Department Unsatisfactory Equipment Report) (fig. 33)

This form will be used for reporting manufacturing, design, or operational defects in equipment and will be completed in triplicate as directed on this form by the person in charge of maintaining the equipment. One copy will be retained on file by the using or service organization, and two copies for the use of the technical service will be forwarded to the railway grand division headquarters in theaters of operations, or to the zone transportation officer, At-

tion: the zone master mechanic in the zone of interior.

224. Operating and Inspection Report Forms for Locomotive Cranes, Derricks, and Pile Drivers

a. Steam locomotive cranes, derricks and pile drivers will be inspected and reported as follows:

(1) Monthly on WD AGO Form 55-227.

(2) Annually on WD AGO Form 55-228.

(3) Quarterly air brake inspection on WD AGO Form 55-235.

b. Other than steam locomotive cranes, derricks and pile drivers will be inspected and reported as follows:

(1) Monthly on WD AGO Form 55-230.

(2) Quarterly air brake inspection on WD AGO Form 55-235.

c. Copies of the completed forms will be placed in the cab of the crane, derrick or pile driver.

d. Daily inspection WD AGO Form 55-226 will be prepared whenever steam or other than steam locomotive crane, derrick or pile driver arrives at an engine terminal.

e. All of the above forms will be completed and forwarded in accordance with the instructions governing the preparation of operating and inspection reports for steam and other than steam locomotives.

225. Territorial Departments and Commands

Installations located outside the continental limits of the United States which are under the jurisdiction of territorial departments or commands will forward two copies of WD AGO Forms 55-151, 55-152, and 55-228, to the Chief of Transportation, U. S. Army, Washington 25, D. C. Reports herein required to be forwarded to the zone master mechanic (zone of interior) will be forwarded to the commanding general of the department or command having jurisdiction over the installation in which the equipment is operated and maintained.

226. Requisitioning Forms

Forms will be requisitioned through normal channels from Adjutant General depots in numbered service commands by installations within the continental limits of the United States, and from the port of embarkation, Adjutant General depots, by installations located outside the continental limits of the United States. (See FM 21-6 and W.D. Pamphlets 12-6 and 12-3.)

WD AGO FORM 55-235 This form supersedes wd ago 55-235, 21 June 1944 (old WD MRS 512, 1 March 1944), and WD AGO 55-229, 15 August 1944 (old WD MRS 505, undated), which may be used until existing stocks are exhausted.

LOCOMOTIVE INSPECTION, CLEANING AND TEST RECORD											LOCOMOTIVE NUMBER		YEAR			
Items 1 to 11 for steam; 1 to 5 for other than steam.											USA-					
ITEM NO.	ITEM	MAXIMUM TEST INSPECTION OR CLEANING PD.	PREVIOUS TEST	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	
1	AIR COMPRESSOR (Orifice Test)	3 MOS.														
2	MAIN AIR RESERVOIR (Hydrostatic Test)	12 MOS.														
3	MAIN AIR RESERVOIR (Hammer Test)	18 MOS.														
4	AIR GAUGES	3 MOS.														
5	DISTRIBUTING OR CONTROL VLVS.	CLEANED AND TESTED 6 MOS.														
	REDUCING VALVES															
	TRIPLE VALVES															
	STR. AIR DOUBLE CHECK VLVS.															
	DIRT COLLECTORS															
	BRAKE PIPE VENT VALVES															
BRAKE CYLINDERS																
6	PULLING BAR AND PINS (Removed and Inspected)	3 MOS.														
7	BOILER, HYDROSTATIC TEST PRESSURE	1 YEAR														
8	BOILER, REMOVAL FLEXIBLE STAYBOLT CAPS	2 YEARS														
9	BOILER, REMOVAL OF FLUES	4 YEARS														
10	BOILER, REMOVAL OF LAGGING	5 YEARS														
11	TENDER TANK (Interior Inspection)	1 MO.														

Front.

Figure 29. WD AGO Form 55-235 (Locomotive

MONTH	ITEMS	SIGNATURE OF INSPECTOR	STATION
JAN.			
FEB.			
MAR.			
APR.			
MAY			
JUNE			
JULY			
AUG.			
SEPT.			
OCT.			
NOV.			
DEC.			

Back.

Inspection, Cleaning and Test Record).

STEAM LOCOMOTIVE SPECIFICATION CARD

Locomotive covered _____ Assignment _____

Type _____ Gage _____ Builder _____ Date _____

U. S. Army Spec. No. _____ Builder's Spec. No. _____

1. Cylinders:
Diameter _____ Stroke _____ Number of cylinders _____

2. Drivers:
Rim diameter _____ Diameter centers _____ Journal sizes _____

3. Wheel base:
Driving _____ Rigid _____ Total engine _____ Engine tender _____

4. Weights in working order:
Drivers _____ Front truck _____ Rear truck _____

Total engine _____ Engine and tender _____

5. Trucks:
Diameter wheels, front truck _____ Journal size _____

Diameter wheels, rear truck _____ Journal size _____

6. Tender capacity:
Water _____ Fuel _____ Type of fuel _____

7. Tender truck:
Diameter wheels _____ Journal size _____

8. Boiler:
Type _____ Diameter _____ Pressure _____

Tubes, number _____ Tubes, diameter _____ Flues, number _____

Flues, diameter _____ Tubes and flues, length _____

9. Heating surfaces:
Firebox and arch tubes and syphons _____ Tubes and flues _____

Superheating surface _____ Evaporative total _____

10. Grate area _____ 11. Traction effort _____

12. Factory adhesion _____ 13. Valve gear _____ 14. Reverse gear _____

15. Lubricators _____ 16. Injectors _____ 17. Grates _____

18. Sanders _____ 19. Draft gear _____ 20. Type and size couplers _____

21. Additional information (special equipment) _____

WD AGO Form 55-236

1 January 1945

This form supersedes W. D., T. C., M. R. S. Form 514, 1 March 1944,
which may be used until existing stocks are exhausted.

16-4230-1

Front.

Figure 30. WD AGO Form 55-236

INTERNAL COMBUSTION LOCOMOTIVE SPECIFICATION CARD

Locomotive covered Assignment

Type Gage Builder Date

U. S. Army Spec. No. Builder's Spec. No.

1. Wheel base:

One truck Locomotive

2. Drivers:

Rim diameter Diameter centers Journal size

3. Weight in working order:

On drivers Total locomotive

4. Capacity:

Fuel Oil Cooling water

Lubricating oil Sand

5. Tractive force starting

6. Ratio adhesion

7. Horsepower **8. Maximum speed**

9. Gear ratio

10. Engine:

Type Cylinder—Bore and stroke

11. Electrical:

Generators Motors Control equipment

Batteries Headlights

12. Type and size of couplers **13. Draft gear**

14. Air brakes **15. Minimum radius**

16. Additional information (special equipment)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

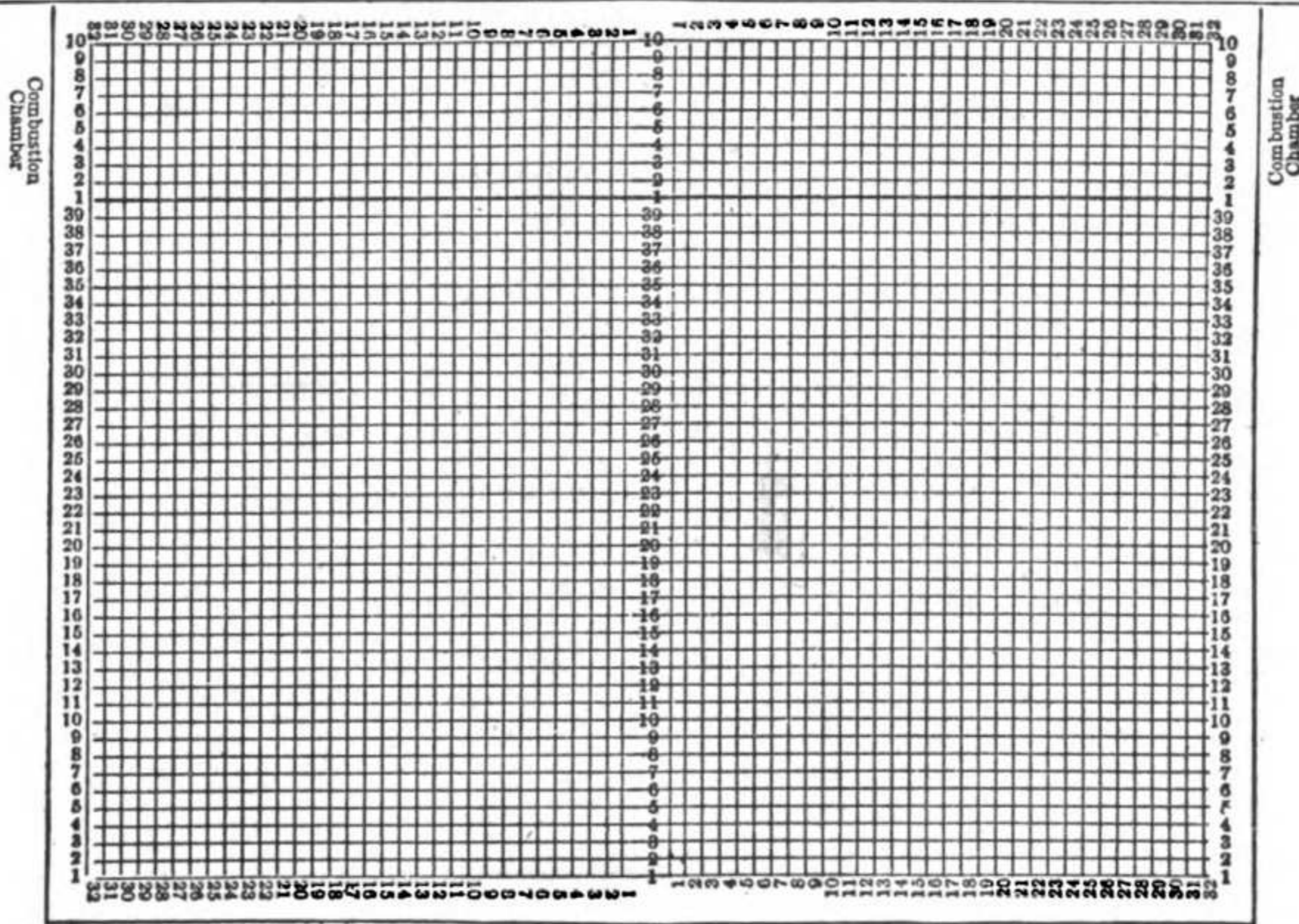
U. S. GOVERNMENT PRINTING OFFICE 16-4889-1

Back.

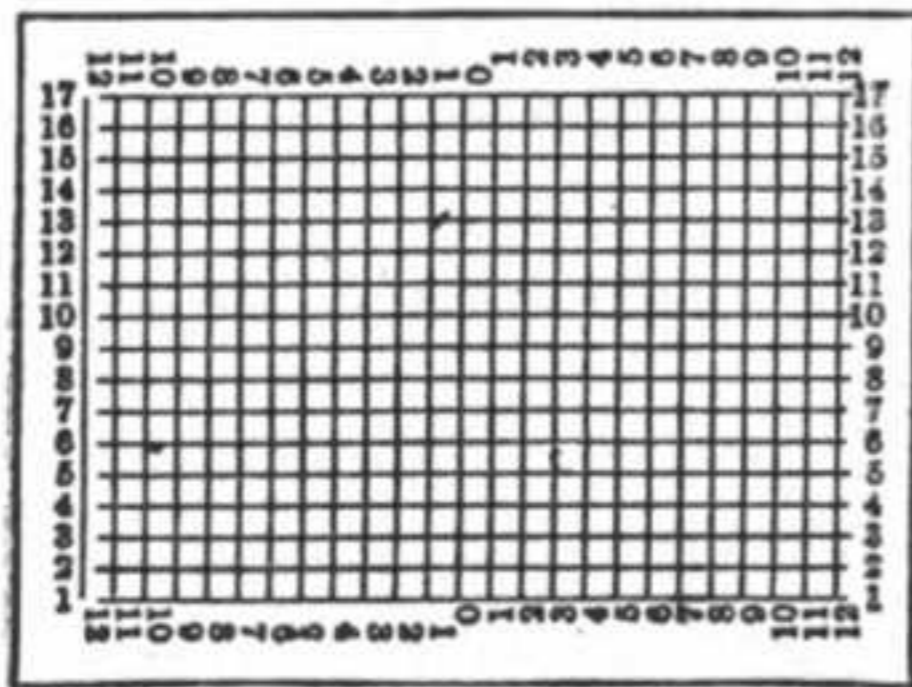
REPORT OF BROKEN STAY BOLTS

STATION _____ ENGINE No. _____ DATE _____

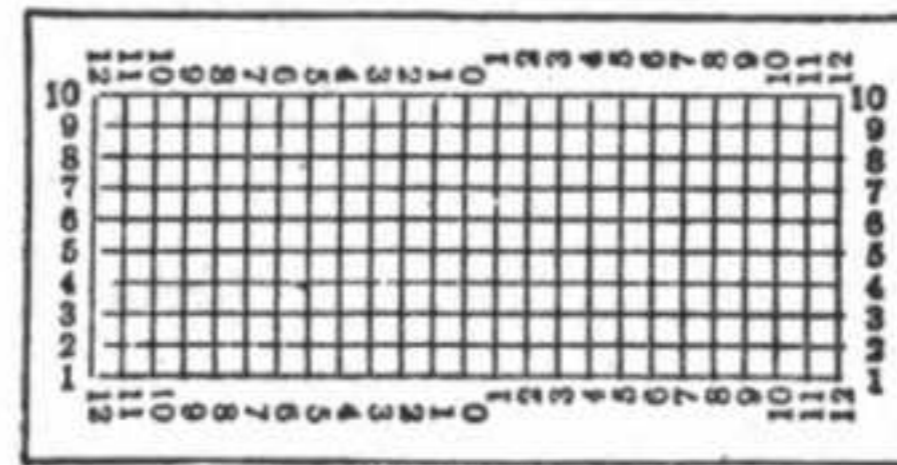
FRONT



LEFT BACK RIGHT
CROWN AND SIDE SHEETS



LEFT BOTTOM RIGHT
DOOR SHEET



LEFT BOTTOM RIGHT
THROAT SHEET

Use Symbols:

	Broken		Renewed
Plain bolts.....	X	.....	⊗
Hollow bolts.....	/	.....	⊘
Flexible bolts.....	.	.....	○
Removed for reasons other than broken.....		.....	○

Place symbol on intersection of lines representing location of bolt.
Use ink for marking.

LOCATION	BROKEN			RENEWED		
	PLAIN	HOLLOW	FLEX	PLAIN	HOLLOW	FLEX
Side R.						
" L.						
Crown						
Door						
Throat						

Number broken flue sheet bridges: _____

Remarks: _____

Signed _____ Approved _____
Inspector. Commanding Officer.

W. D., A. G. O., Form No. 55-239
1 January 1945 -

This form supersedes TC MRS 521, undated, which may be used until existing stocks are exhausted.

U. S. GOVERNMENT PRINTING OFFICE 16-57770-1

Figure 31. WD AGO Form 55-239 (Report of Broken Stay Bolts).

MONTHLY REPORT ON CONDITION OF LOCOMOTIVES AND LOCOMOTIVE CRANES						LOCATION		SIGNATURE OF COMMANDING OFFICER						FOR THE LAST DAY OF		
LOCOMOTIVE OR CRANE NUMBER USA	LAST CLASS 3 REPAIRS OR HEAVIER		LAST CLASS 4 OR 5 REPAIRS		MILEAGE MADE		FLUES AND TUBES		TIRES		REPAIRS REQUIRED		IN AND AWAITING SHOP FOR CLASS REPAIRS			GENERAL CONDITION G-Good F-Fair P-Poor
	DATE	CLASS	DATE	CLASS	SINCE LAST CLASS 3 OR HEAVIER 4 OR 5		CON- DITON	LIFE IN MONTHS	THICK- NESS	WEAR IN 32 WDS.	MONTH	CLASS	IN	OUT	CLASS	

WD AGO FORM 55-240 This form supersedes TC MRS Form 527, undated, and WD AGO Form 55-240, 15 July 1944, which may be used until existing stocks are exhausted. 1 February 1945

Figure 32. WD AGO Form 55-240 (Monthly Report on Condition of Locomotives and Locomotive Cranes).

WAR DEPARTMENT UNSATISFACTORY EQUIPMENT REPORT										
FOR	TECHNICAL SERVICE						MATERIEL		DATE	
FROM	ORGANIZATION								STATION	
TO	NEXT SUPERIOR HEADQUARTERS				STATION		TECHNICAL SERVICE			
COMPLETE MAJOR ITEM										
NOMENCLATURE			TYPE			MODEL				
MANUFACTURER			U. S. A. REG. No.		SERIAL No.		DATE RECEIVED			
EQUIPMENT WITH WHICH USED (if applicable)										
DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE										
PART No.		TYPE		MANUFACTURER				DATE INSTALLED		
DESCRIPTION OF FAILURE AND PROBABLE CAUSE (if additional space is required, use back of form)										
DATE OF INITIAL TROUBLE			TOTAL TIME INSTALLED			TOTAL PERIOD OF OPERATION BEFORE FAILURE				
			YEARS	MONTHS	DAYS *	YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN										
TRAINING OR SKILL OF USING PERSONNEL			RECOMMENDATIONS (if additional space is required, use back of form)							
POOR	FAIR	GOOD								
ORIGINATING OFFICER										
TYPED NAME, GRADE, AND ORGANIZATION					SIGNATURE					
FIRST ENDORSEMENT										
TO CHIEF		TECHNICAL SERVICE				OFFICE				
NAME, GRADE, AND STATION					STATION		DATE			
Instructions										
<ol style="list-style-type: none"> 1. It is imperative that the chief of technical service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data. 2. This form will be used for reporting manufacturing, design, or operational defects in matériel, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of matériel. 3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records. 4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (change No. 3). 5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable. 6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means. 7. This form will be made out in triplicate by using or service organization. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels. 8. Necessity for using this form will be determined by the using or service troops. 										
W. D., A. G. O. Form No. 468 30 August 1944					This form supersedes W. D., A. G. O. Form No. 468, 1 December 1943, which may be used until existing stocks are exhausted.					
U. S. GOVERNMENT PRINTING OFFICE 16-31540-1										

Figure 33. WD AGO Form 55-468 (Unsatisfactory Equipment Report).

VACUUM BRAKE AND COMBINED VACUUM AND AIR BRAKE EQUIPMENT FOR LOCOMOTIVES

1. General

The vacuum brake is a simple and efficient means of providing power for lightweight vehicles. Although this type of brake is not common in the United States, it is extensively used in the South American republics, Africa, Italy, India, and Great Britain. The details of operation and maintenance of the vacuum brake and combined vacuum and air brake equipment are beyond the scope of this manual. For fundamentals of operation, all personnel should study the War Department Technical Manual accompanying this type of equipment.

2. Automatic Vacuum Brake

a. In a vacuum brake system, the maximum available pressure for applying the brakes is less than that of the atmosphere. Consequently, much larger brake cylinders are necessary in order to provide the needed force than is the case with the compressed air brake systems used in this country.

b. The train pipe and vacuum chambers are carried at a sub-atmospheric pressure during "release" and "running" operations. The pressures on both sides of the brake cylinder piston are thereby equalized and the braking force is removed from the brake shoes. To apply the brakes, the vacuum which is present in the train line is reduced by admitting air from the outside atmosphere to the train line. This inflow of air causes a difference in pressure across the brake cylinder piston and thereby creates a force which is transmitted through the brake rigging and applies the brake shoe.

c. A steam ejector on a locomotive makes use of steam at boiler pressure to create a vacuum in the vacuum reservoirs and train pipe until such time as it is desired to apply the brakes. The vacuum reduction attachment of the steam ejector controls the amount of vacuum obtained in the train line to a constant maximum value irrespective of the variations in steam pressure. The brake cylinders are connected with one side of their pistons open to the train line and the other side open to a vacuum chamber which is evacuated to train line conditions through a ball-type check valve. To apply the

brakes, it is only necessary to reduce partially the vacuum on the application side of the brake cylinder pistons without disturbing it on the vacuum chamber side. This is done by admitting air from the outside atmosphere into the train line. The greatest amount of power is derived from the brake cylinder by maintaining the vacuum on the vacuum chamber side of the piston and completely destroying the vacuum in the train line.

d. The vacuum system is made up of two separate pipe lines connected to the steam ejector. The first line is for the locomotive and tender only, and connects the vacuum reservoirs and the chambers above the brake cylinder piston to the vacuum chamber connection of the steam ejector. The second line runs the entire length of the train and is made up of permanently fixed lines on each individual car, locomotive, and tender, coupled between the cars with a flexible hose and coupling. This train line is connected to the main train line connection of the ejector, to the brake cylinders of each vehicle and to all vacuum chambers through a ball valve. The ends of the line, both at the head end of the locomotive and the rear end of the last car, are closed by placing the couplings on dummy coupling plugs for that purpose. Atmospheric pressure forces the coupling gaskets to seal on the plugs, thereby effectively closing the ends of the system.

e. On heavy locomotives it is customary to use live steam in the driver brake cylinders while vacuum brakes are used on the tender. The admittance of steam and the exhausting of steam from the steam brake cylinders, is controlled by the operator through the use of a steam brake attachment which is applied to the steam ejector. Special brake cylinders are used.

3. Combined Vacuum and Air Brake Equipment

a. This equipment is a combination of vacuum and compressed air for Diesel-electric locomotives which are to haul cars already equipped with vacuum brake equipment.

b. The locomotive brakes are operated by compressed air either independently of the train brakes,

or in conjunction with them, in which case the vacuum system acts as a pilot for the air brake system.

c. For the fundamentals of operation, all personnel will study the War Department Technical Manual accompanying this equipment.

APPENDIX II

CONDEMNING LIMITS FOR MOTOR-DRIVEN AIR COMPRESSORS

Westinghouse Type DH-10-Orifice Size No. 46 Drill-0.081-inch Diameter

Shaft rpm		Elevation in feet above sea level								
		Minimum gauge pressure in pounds to be maintained.								
Com-pressor	Motor	Sea level	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000
260	1,380	56	54	52	50	48	46	44	43	41
240	1,270	53	51	49	47	45	44	42	40	39
220	1,163	48	46	45	43	41	40	38	37	35
215	1,140	47	45	44	42	40	39	37	36	35
210	1,110	46	44	43	41	39	38	36	35	34
205	1,087	45	43	42	40	39	37	36	34	33
200	1,060	44	42	41	39	38	36	35	34	32
195	1,032	43	41	40	38	37	35	34	33	31
190	1,010	42	40	39	37	36	34	33	32	30
185	981	40	39	37	36	35	33	32	31	.....
180	955	39	37	36	35	33	32	31	.....	.....
175	928	38	36	35	34	32	31	30	.....	.....
170	901	37	35	34	33	31	30	.....	.....	.....
165	875	35	34	33	31	30	.....	.....	.....	.....
160	850	34	33	32	30	.....	.....	.....	.....	.....
155	823	33	32	30	.....	.....	.....	.....	.....	.....
150	795	32	30	.....	.....	.....	.....	.....	.....	.....
145	770	31	.....	.....	.....	.....	.....	.....	.....	.....

Westinghouse Type DH-16-Orifice Size No. 37 Drill-0.104-inch Diameter

Shaft rpm		Elevation in feet above sea level								
		Minimum gauge pressure in pounds to be maintained								
Com-pressor	Motor	Sea level	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000
250	1,280	56	54	52	50	48	46	44	42	41
240	1,230	54	52	50	48	46	44	43	41	39
230	1,180	51	49	47	46	44	42	41	39	38
225	1,155	50	48	46	44	43	41	40	38	37
220	1,130	49	47	45	43	41	40	38	37	36
215	1,100	48	46	45	43	41	40	38	37	35
210	1,080	46	45	43	41	40	38	37	35	34
205	1,050	45	43	42	40	39	37	36	34	33
200	1,025	44	42	41	39	38	36	35	33	32
195	1,000	43	41	39	38	36	35	34	32	31
190	975	41	40	38	37	35	34	33	31	30
185	950	40	39	37	36	34	33	32	30	30
180	925	39	37	36	35	34	32	31	30	.....
175	900	38	36	35	34	32	31	30	.....	.....
170	875	36	35	34	32	31	30	.....	.....	.....
165	845	35	34	33	31	30	.....	.....	.....	.....
160	820	34	33	31	30	.....	.....	.....	.....	.....
155	795	33	31	30	.....	.....	.....	.....	.....	.....
150	770	31	30	.....	.....	.....	.....	.....	.....	.....
145	745	30	.....	.....	.....	.....	.....	.....	.....	.....

Westinghouse-Type F-3-B Orifice Size No. 26 Drill-0.1470-inch Diameter

Shaft rpm		Elevation in feet above sea level								
		Minimum gauge pressure in pounds to be maintained								
Com-pressor	Motor	Sea level	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000
250	Belt-driven	83	80	77	74	71	68	65	63	61
240		81	78	75	72	69	67	64	62	59
230		79	76	73	70	67	65	62	60	57
225		77	74	71	68	66	63	61	59	56
220		75	72	70	67	64	62	60	57	55
215		74	71	69	66	63	61	59	56	54
210		72	69	66	64	61	59	57	55	53
205		70	67	65	62	60	58	55	53	51
200		69	67	64	62	60	57	55	53	51
195		67	65	62	60	57	55	53	51	49
190		65	62	60	58	55	53	51	50	48
185		63	61	59	57	55	53	51	49	47
180		62	59	57	55	52	50	48	46	44
175		60	58	55	53	51	49	47	46	44
170		58	56	54	52	50	48	46	45	43
165		57	55	52	50	48	47	45	43	42
160		55	53	51	49	48	46	44	42	41
155		54	52	50	48	46	44	43	41	40
150		53	51	49	47	45	43	42	40	39
145		51	49	47	45	43	42	40	39	37
140	49	47	46	44	42	41	39	38	36	

Westinghouse-Type D-4-N-Orifice Size 5/32-inch Drill

Shaft rpm		Elevation in feet above sea level								
Com-pressor	Motor	Minimum gauge pressure in pounds to be maintained .								
		Sea level	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000
240	1,305	80	77	74	71	68	65	63	61	58
230	1,250	78	75	72	69	66	63	61	59	57
220	1,200	77	74	71	68	65	63	61	58	56
215	1,170	75	72	69	66	64	61	59	57	54
210	1,140	73	70	67	65	62	60	57	55	53
205	1,115	71	68	66	63	61	58	56	54	52
200	1,090	70	67	65	62	60	57	55	53	51
195	1,060	68	65	63	60	58	56	53	51	49
190	1,030	67	64	62	59	57	55	53	51	49
185	1,000	65	62	60	58	55	53	51	49	47
180	980	63	60	58	56	54	52	50	48	46
175	950	61	59	56	54	52	50	48	46	44
170	925	60	58	55	53	51	49	47	45	43
165	895	58	56	53	51	49	48	46	44	42
160	870	57	55	52	50	48	46	45	43	41
155	840	55	53	51	49	47	45	43	42	40
150	815	53	51	49	47	45	43	42	40	38
145	790	51	49	47	44	43	41	39	38	37
140	760	50	48	46	44	43	41	39	38	37
135	735	48	46	44	42	41	40	38	37	35
130	705	47	45	43	41	40	38	37	36	34

Westinghouse-Type D-4-P and D-4-K-Orifice Size 5/32-inch Drill

Shaft r. p. m.			Elevation in feet above sea level								
Com-pressor	Motor		Minimum gauge pressure in pounds to be maintained								
	D-4-P	D-4-K	Sea level	1000	2000	3000	4000	5000	6000	7000	8000
230	1,250	1,380	82	79	76	73	70	67	65	62	60
220	1,200	1,320	80	77	74	71	68	65	63	61	58
210	1,140	1,260	78	75	72	69	66	64	62	59	57
205	1,115	1,230	76	73	70	67	65	62	60	58	56
200	1,090	1,200	74	71	68	65	63	61	58	56	54
195	1,060	1,170	72	69	66	64	62	59	57	55	53
190	1,030	1,140	70	67	65	62	60	58	55	53	51
185	1,000	1,110	68	65	63	61	58	56	54	52	50
180	980	1,080	66	63	61	59	57	54	52	50	48
175	950	1,050	64	61	59	57	55	53	51	49	47
170	925	1,020	62	60	57	55	53	51	49	47	45
165	895	990	60	58	56	54	52	50	49	47	45
160	870	960	58	56	54	52	50	48	46	44	43
155	840	930	56	54	52	50	48	46	44	43	41
150	815	900	54	52	50	48	46	44	43	41	40
145	790	870	52	50	48	46	44	43	41	40	38
140	760	840	50	48	46	44	43	41	39	38	36
135	735	810	48	46	44	43	41	39	38	37	35
130	705	780	46	44	42	41	39	38	36	35	33
125	680	750	44	42	41	39	38	36	35	34	32

Westinghouse-Types C-60 and XC-60-Orifice Size No. 22 Drill-0.157-inch Diameter.

Shaft rpm		Elevation in feet above sea level									
Com-pressor	Motor		Minimum gauge pressure in pounds to be maintained								
	C-60	XC-60	Sea level	1000	2000	3000	4000	5000	6000	7000	8000
240	1,080	1,290	99	95	91	88	85	81	78	75	72
230	1,035	1,240	97	93	90	86	83	80	77	74	71
220	990	1,180	94	90	87	84	80	77	74	71	68
210	945	1,130	92	88	85	82	78	75	73	70	67
205	925	1,100	89	85	82	79	76	73	70	67	65
200	900	1,075	87	84	80	77	74	71	68	66	63
195	880	1,050	84	81	78	75	72	69	66	64	61
190	855	1,020	82	79	76	73	70	67	65	62	60
185	835	995	79	76	73	70	67	65	62	60	..
180	810	965	77	74	71	68	65	63	61	..	..
175	790	940	74	71	68	65	63	61	..	..	..
170	765	915	72	69	66	64	61	..	..	..	..
165	745	885	69	66	64	61	..	..	..	..	..
160	720	860	67	64	62	60	..	..	..	..	..
155	700	830	64	62	60	..	..	..	..	..	..
150	675	805	62	60	..	..	..	..	..	..	..

Westinghouse-Type D-3-F—Orifice Size No. 29 Drill-0.136-inch Diameter

Shaft rpm		Elevation in feet above sea level									
Com-pressor	Motor	Minimum gauge pressure in pounds to be maintained									
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000	
240	1,480	86	83	80	77	74	71	68	65	63	
220	1,356	79	76	73	70	68	65	63	60	58	
200	1,232	72	69	66	64	61	59	57	55	53	
195	1,200	70	67	65	62	60	57	55	53	51	
190	1,170	68	66	63	61	58	56	54	52	50	
185	1,140	66	64	61	59	57	54	52	50	48	
180	1,110	64	62	60	57	55	53	51	49	47	
175	1,080	63	60	58	56	54	52	50	48	46	
170	1,048	61	59	56	54	52	50	48	46	44	
165	1,018	59	57	55	53	51	49	47	45	43	
160	986	57	55	53	51	49	47	45	43	42	
155	955	55	53	51	49	47	46	44	42	40	
150	925	54	52	50	48	46	44	42	41	39	
145	894	52	50	48	46	44	43	41	39	38	
140	863	50	48	46	44	43	41	39	38	36	
135	833	48	46	45	43	41	40	38	37	35	
130	802	46	45	43	41	40	38	37	35	34	
125	770	45	43	41	40	38	37	35	34	33	
120	740	43	41	40	38	37	35	34	33	31	
115	708	41	39	38	36	35	34	32	31	30	
110	678	39	38	36	35	34	32	31	30	29	
105	647	37	36	35	33	32	31	29	28	..	
100	616	36	34	33	32	30	29	28	..	..

Westinghouse—Type D-2-EG—Orifice Size 7/64-inch Drill

Shaft rpm		Elevation in feet above sea level								
Com-pressor	Motor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
280	1,550	89	85	82	79	76	73	70	67	65
270	1,500	86	82	80	76	74	72	69	66	64
260	1,440	83	80	76	73	70	68	65	63	60
250	1,380	80	77	74	71	68	65	63	60	58
245	1,350	78	75	72	69	66	64	61	59	57
240	1,330	77	74	71	68	65	63	60	58	56
235	1,300	75	72	69	66	64	61	59	57	55
230	1,275	74	71	68	65	63	60	58	56	54
225	1,250	72	69	66	64	61	59	57	55	53
220	1,220	71	68	65	63	60	58	56	54	52
215	1,190	69	66	64	61	59	57	55	53	51
210	1,160	68	65	63	60	58	56	54	52	50
205	1,135	66	63	61	58	56	54	52	50	48
200	1,110	65	62	60	58	55	53	51	49	47
195	1,080	63	60	58	56	54	52	50	48	46
190	1,050	62	59	57	55	53	51	49	47	45
185	1,025	60	58	56	53	51	49	47	44	43
180	995	59	57	54	52	50	48	46	44	42
175	970	57	55	53	51	49	47	45	43	41
170	940	56	54	52	50	48	46	44	42	40
165	915	54	52	50	48	46	44	42	40	39
160	885	53	51	49	47	45	43	41	40	38
155	860	51	49	47	45	43	41	40	38	37
150	830	40	47	45	44	43	41	40	38	37

Westinghouse—Types D-3-N and D-3-LA—Orifice size No. 29 Drill—0.1360-inch Diameter

Shaft rpm			Elevation in feet above sea level								
Com-pressor	Motor		Minimum gauge pressure in pounds to be maintained								
	D-3-N	D-3-LA	Sea level	1000	2000	3000	4000	5000	6000	7000	8000
250	1650	1070	79	76	73	70	67	65	62	60	58
240	1588	1030	76	73	70	67	65	62	60	57	55
230	1520	985	73	70	67	65	62	60	57	55	53
220	1453	942	70	67	64	62	59	57	55	53	51
215	1420	921	68	65	63	60	58	55	53	51	49
210	1390	900	66	63	61	59	56	54	52	50	48
205	1355	878	64	62	60	57	55	53	51	49	47
200	1320	856	63	60	58	56	54	52	50	48	46
195	1290	835	61	59	57	54	52	50	48	46	45
190	1255	814	60	58	55	53	51	49	47	45	44
185	1225	792	58	56	54	51	49	48	46	44	42
180	1190	772	57	55	53	51	49	47	45	43	42
175	1155	750	56	54	52	50	48	46	44	42	41
170	1123	728	54	52	50	48	46	44	43	41	40
165	1090	707	53	51	49	47	45	43	41	40	38
160	1058	685	51	49	47	45	44	42	40	39	37
155	1025	665	49	48	46	44	42	41	39	37	36
150	990	643	48	46	44	42	41	39	38	36	35
145	956	621	46	44	43	41	39	38	36	35	34
140	925	600	45	43	41	40	38	37	35	34	33

Westinghouse—Type C-75—Orifice Size No. 16 Drill—0.177-inch Diameter

Shaft rpm			Elevation in feet above sea level								
Com-pressor	Motor		Minimum gauge pressure in pounds to be maintained								
	Gear ratio 3.37	Gear ratio 4.72	Sea level	1000	2000	3000	4000	5000	6000	7000	8000
270	910	1275	90	86	83	80	77	75	72	69	66
260	875	1230	86	83	79	76	73	70	68	65	62
250	844	1180	82	79	76	73	70	67	65	62	60
245	825	1155	80	77	74	71	68	66	63	61	..
240	810	1130	78	75	72	69	67	64	61	..	..
235	792	1110	76	73	70	67	65	62	60	..	..
230	775	1085	74	71	68	66	63	61	..	..	..
225	758	1060	72	69	66	64	61	..	..	..	..
220	742	1040	70	67	65	62	60	..	..	..	..
215	725	1015	68	65	63	60	..	..	..	..	..
210	708	990	66	63	61	..	..	..	..	..	..
205	691	968	64	61	..	..	..	..	..	..	..
200	674	945	62	60	..	..	..	..	..	..	..
195	655	920	60	..	..	..	..	..	..	..	..

Westinghouse—Type CA-150—Orifice Size 15/64-inch Drill

Shaft rpm		Elevation in feet above sea level								
Com-pressor	Motor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
135	1620	118	113	109	105	101	97	93	90	86
130	1560	113	108	104	100	96	92	88	85	82
125	1500	108	104	100	96	93	89	86	82	79
120	1440	103	99	95	92	88	85	81	78	75
115	1380	98	95	91	88	84	81	78	75	72
110	1320	94	90	87	83	80	77	74	71	68
105	1260	89	86	82	79	76	73	71	68	65
100	1200	84	81	78	75	72	69	66	64	62
95	1140	79	76	73	70	68	65	63	60	..
90	1080	74	72	69	66	64	61	..	..	..
85	1020	70	67	65	62	60	..	..	..	..
80	960	65	62	60	..	..	..	..	..	..
75	900	60	..	..	..	..	..	..	..	..

General Electric—Types CP-30-1500 and 1200—Orifice Size No. 29 Drill—0.136-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Motor	Com-pressor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
1350	239	73	70	67	65	62	59	56	53	50
1300	230	70	68	65	62	59	57	54	51	48
1250	222	68	65	62	60	57	55	52	49	46
1200	213	65	63	60	58	55	53	50	48	45
1150	204	63	60	58	55	53	51	48	45	43
1100	195	60	58	55	53	51	48	45	43	41
1050	186	58	55	53	51	48	46	44	41	39
1000	177	55	53	51	48	46	44	41	39	37
950	168	52	50	48	46	44	41	39	37	35
900	159	50	48	46	43	41	39	37	35	33
850	151	47	45	43	41	39	37	35	33	31
800	142	44	42	40	38	36	34	32	30	28
750	133	41	39	37	35	34	32	30	28	26

General Electric—Type CP-30-600—Orifice Size No. 29 Drill—0.136-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Motor	Com-pressor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
1300	230	70	68	65	62	59	57	54	51	48
1250	222	68	65	62	60	57	55	52	49	46
1200	213	65	63	60	58	55	52	49	46	43
1150	204	63	60	58	55	53	50	47	44	41
1100	195	60	58	55	53	51	48	45	42	39
1050	186	58	55	53	51	48	45	42	40	37
1000	177	55	53	51	48	45	42	40	37	34
950	168	52	50	47	45	42	40	37	34	32
900	159	49	47	45	42	40	37	34	32	30
850	151	46	44	41	39	36	33	31	29	27
800	142	42	40	38	35	33	31	29	27	25
750	133	39	37	35	33	31	29	26	24	22

General Electric—Types CP-29-1500 and 1200—Orifice Size 7/64-inch Drill—0.1094-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Motor	Com-pressor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
1500	274	82	78	74	70	66	62	59	55	51
1400	256	77	73	70	66	62	59	55	51	48
1300	238	72	69	65	62	58	55	51	48	44
1200	219	67	64	60	57	54	51	47	44	41
1100	201	62	59	56	52	49	46	43	40	37
1000	183	56	53	51	48	45	42	39	36	34
900	165	51	48	46	43	40	38	35	32	30

General Electric—Type CP-28-600—Orifice Size 7/64-inch Drill—0.1094-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Motor	Com-pressor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
1450	265	80	76	72	68	65	61	57	53	49
1350	247	75	71	67	64	60	57	53	50	46
1250	228	70	66	63	60	56	53	49	46	43
1150	210	65	61	58	55	52	48	45	42	39
1050	192	59	56	53	50	47	44	41	38	35
950	174	53	51	48	45	42	40	37	34	32
850	155	48	45	43	40	38	35	33	30	28
750	137	42	40	37	35	33	31	28	26	24

General Electric—Type CP-26—Orifice Size 13/64-inch Drill—0.2031-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Motor	Com-pressor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
950	230	114	109	104	99	94	89	83	78	73
900	218	108	103	98	93	88	83	78	73	68
850	206	101	96	92	87	82	77	73	68	63
800	194	94	90	85	81	76	72	68	63	59
750	182	87	83	79	75	71	67	63	59	55
700	170	80	76	73	69	65	61	57	54	50
650	158	73	69	66	63	59	56	52	49	45
600	146	67	63	60	57	54	50	47	44	41
550	133	60	57	54	51	48	45	42	39	36
500	121	53	50	48	45	42	40	37	34	32

General Electric—Type CP-19—Orifice Size No. 18 Drill—0.1695-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Motor	Com-pressor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
	220	106	101	96	91	87	82	77	72	68
	210	102	97	92	88	83	79	74	69	65
	200	97	92	87	83	79	74	70	65	61
	190	93	88	84	80	75	71	67	63	58
	180	88	84	80	76	71	67	63	59	55
	170	83	79	75	71	67	63	60	56	52
	160	78	74	71	67	63	59	56	52	48
	150	73	70	66	63	59	56	52	48	45
	140	68	65	61	58	55	51	48	45	42
	130	63	60	57	54	51	47	44	41	38

General Electric—Type CP-34—Orifice Size 15/64-inch Drill—0.2344-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Com-pressor	Motor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
250	1140	123	118	112	107	101	96	90	85	79
240	1094	118	112	107	102	96	91	86	81	75
230	1049	112	107	102	97	92	87	82	77	71
220	1004	107	102	97	92	87	82	78	73	68
210	958	101	96	92	87	82	78	73	69	64
200	912	96	91	87	82	78	73	69	64	60
190	867	90	86	82	77	73	69	64	60	56
180	822	85	81	77	73	69	65	61	57	53
170	776	79	75	71	67	64	60	56	53	49
160	730	73	70	66	63	59	56	53	49	45
150	685	68	65	61	58	55	52	48	45	42

General Electric—Type CP-33—Orifice Size 13/64-inch Drill—0.2031-inch Diameter

Shaft rpm		Elevation in feet above sea level								
Com-pressor	Motor	Minimum gauge pressure in pounds to be maintained								
		Sea level	1000	2000	3000	4000	5000	6000	7000	8000
235	1050	117	111	106	101	96	91	86	80	75
224	1000	111	106	101	96	91	86	81	76	71
213	950	105	100	95	90	85	80	75	71	66
202	900	98	94	90	85	80	76	71	67	62
190	850	92	88	83	79	75	70	66	62	58
179	800	86	82	78	74	69	65	61	57	53
168	750	79	75	72	68	64	60	57	53	49
157	700	73	69	66	62	59	55	52	48	45
145	650	67	64	60	57	54	51	48	44	41
134	600	60	57	54	51	48	45	42	39	36

NUMERICAL INDEX OF REGULATIONS GOVERNING INSPECTION AND TESTING OF STEAM LOCOMOTIVES (CH. 4)

- | <i>1. BOILERS AND THEIR APPURTENANCES</i> | <i>Water Glass and Gauge Cocks</i> |
|---|--|
| <p style="text-align: center;"><i>Rules for Inspection</i></p> <p><i>Rule No.</i></p> <p>1. Responsibility.</p> <p style="text-align: center;"><i>Inspection of Interior of Boilers</i></p> <p>2. Time of inspection.</p> <p>3. Removal of flues.</p> <p>4. Method of inspection.</p> <p>5. Repairs.</p> <p>6. Lap-joint seams.</p> <p>7. Fusible plugs.</p> <p style="text-align: center;"><i>Inspection of Exterior of Boilers</i></p> <p>8. Time of inspection.</p> <p>9. Lagging to be removed.</p> <p style="text-align: center;"><i>Testing of Boiler</i></p> <p>10. Boilers in service.</p> <p>11. Boilers out of service.</p> <p>12. Removal of dome cap.</p> <p>13. Repairs and steam test.</p> <p style="text-align: center;"><i>Staybolt Testing</i></p> <p>14. Time of testing rigid bolts.</p> <p>15. Method of testing rigid bolts.</p> <p>16. Method of testing flexible staybolts with caps.</p> <p>17. Method of testing flexible staybolts without caps.</p> <p>18. Broken staybolts.</p> <p>19. Telltale holes.</p> <p>20. Drilling telltale holes.</p> <p style="text-align: center;"><i>Steam Gauges</i></p> <p>21. Location of gauges.</p> <p>22. Siphon.</p> <p>23. Time of testing.</p> <p>24. Method of testing.</p> <p>25. Badge plates.</p> <p>26. Boiler number.</p> <p style="text-align: center;"><i>Safety Valves</i></p> <p>27. Number and capacity.</p> <p>28. Setting of safety valves.</p> <p>29. Time of testing.</p> | <p><i>Rule No.</i></p> <p>30. Number and location.</p> <p>31. Water glass valves.</p> <p>32. Time of cleaning.</p> <p>33. Testing and maintenance.</p> <p>34. Water and lubricator glass shields.</p> <p>35. Water glass lamps.</p> <p style="text-align: center;"><i>Injectors</i></p> <p>36. Maintenance.</p> <p style="text-align: center;"><i>Washing Boilers</i></p> <p>37. Time of washing.</p> <p>38. Plugs to be removed.</p> <p>39. Water tubes.</p> <p>40. Office record.</p> <p style="text-align: center;"><i>Steam Leaks</i></p> <p>41. Leaks under lagging.</p> <p>42. Leaks in front of enginemen.</p> <p style="text-align: center;"><i>Reports</i></p> <p>43. Filing reports.</p> <p>44. Accident reports.</p> <p style="text-align: center;">2. BRAKE EQUIPMENT</p> <p>45. Inspection.</p> <p>46. Compressors.</p> <p>47. Testing main reservoirs.</p> <p>48. Air gauges.</p> <p>49. Time of cleaning.</p> <p>50. Testing and tagging.</p> <p>51. Piston travel.</p> <p>52. Foundation brake gear.</p> <p>53. Leakage.</p> <p>54. Train signal system.</p> <p style="text-align: center;">3. CABS, WARNING SIGNALS, AND SANDERS</p> <p>55. Cabs.</p> <p>56. Cab aprons.</p> <p>57. Cylinder cocks.</p> <p>58. Sanders.</p> <p>59. Whistle.</p> |

4. *DRAWGEAR, DRAFT GEAR, DRIVING GEAR
AND RUNNING GEAR*

Draw Gear

Rule No.

- 60. Draw gear.
- 61. Chafing irons.
- 62. Draft gear.

Driving Gear

- 63. Crossheads.
- 64. Guides.
- 65. Pistons and piston rods.
- 66. Rods, main and side.

Running Gear

- 67. Driving, trailing, and engine track axles.
- 68. Defects, tender truck axles.
- 69. Minimum diameters, tender truck axles.
- 70. Crank pins.
- 71. Driving boxes.
- 72. Driving box shoes and wedges.
- 73. Frames.
- 74. Lateral motion.
- 75. Pilots.
- 76. Spring rigging.
- 77. Trucks, leading and trailing.

5. *WHEELS*

- 78. Wheels tight on axle.
- 79. Cast-iron or cast-steel wheels.

Rule No.

- 80. Forged steel and steel-tired wheels.
- 81. Driving and trailing wheels.
- 82. Driving wheel counterbalance.
- 83. Driving and trailing wheel defects.
- 84. Driving and trailing wheel tires.
- 85. Minimum tire thickness.

6. *LIGHTS*

- 86. Maintenance.
- 87. Locomotives used in road service.
- 88. Locomotives used in yard service.
- 89. Cab lights.

7. *THROTTLE AND REVERSING GEAR; ASH PANS*

- 90. Throttles.
- 91. Reverse gear.
- 92. Ash pans.

8. *TENDERS*

- 93. Tender frames.
- 94. Feed water tanks.
- 95. Oil tanks.
- 96. Tender trucks.

9. *REPORTS*

- 97. Filing reports.
- 98. Accident reports.

NUMERICAL INDEX OF REGULATIONS GOVERNING INSPECTION AND TESTING
OF OTHER THAN STEAM LOCOMOTIVES (CH. 6)

- | <i>Rule No.</i> | <i>1. BRAKE EQUIPMENT</i> | <i>Rule No.</i> | |
|-----------------|--|-----------------|--|
| 101. | Air and vacuum brakes. | 132. | Sanders. |
| 102. | Safety valves. | 133. | Train signal system. |
| 103. | Hydrostatic test of main reservoirs. | | <i>5. ELECTRICAL EQUIPMENT</i> |
| 104. | Air gauge location. | 134. | Current collector insulation. |
| 105. | Cleaning. | 135. | Trolley hooks and insulation. |
| 106. | Piston travel. | 136. | De-energized shoes. |
| 107. | Foundation brake gear. | 137. | Emergency pole. |
| 108. | Main reservoir leakage. | 138. | Lightning arrester. |
| | <i>2. DRAW GEAR AND RUNNING GEAR</i> | 139. | Grounding of metal parts. |
| 109. | Draw gear and connections. | 140. | Guard current-carrying parts. |
| | <i>Running Gear</i> | 141. | Doors and cover plates marked "Dangerous". |
| 110. | Axles. | 142. | Hand-operated switches. |
| 111. | Crank pins. | 143. | Jumpers. |
| 112. | Motor, main and side rods. | 144. | Motors and generators. |
| 113. | Jack shafts. | 145. | Transformers. |
| 114. | Quill drive. | 146. | Rheostats and grid resisters. |
| 115. | Gear guards. | 147. | Voltmeters and ammeters. |
| 116. | Driving boxes, shoes, and wedges. | 148. | Insulation dielectric test. |
| 117. | Lateral motion. | 149. | Insulation inspection. |
| 118. | Frames and parts. | | <i>6. INTERNAL COMBUSTION EQUIPMENT</i> |
| 119. | Spring rigging. | 150. | Fuel tanks and piping. |
| 120. | Trucks. | 151. | Filling and venting. |
| 121. | Side bearings. | 152. | Grounding fuel tanks. |
| 122. | Clearance above top of rail. | 153. | Exhaust gases. |
| | <i>3. WHEELS</i> | 154. | Starting device. |
| 123. | Wheels tight on axle. | 155. | Safety hangers. |
| 124. | Wheel defects. | | <i>7. BOILERS</i> |
| 125. | Minimum tire thickness. | 156. | Safe working pressure. |
| | <i>4. CABS, CAB APRONS, PILOTS</i> | 157. | Stresses on staybolts and braces. |
| 126. | Cabs. | 158. | Strength of materials. |
| | <i>Lights</i> | 159. | Boiler number and badge plate. |
| 127. | Headlights. | 160. | Interior inspection. |
| 128. | Classification or marker lights. | 161. | Removal of tubes. |
| 129. | Cab lights. | 162. | Cracks. |
| | <i>Whistles, Bells, Sanders, Train Signals</i> | 163. | Fusible plugs. |
| 130. | Whistle. | 164. | Exterior boiler inspection. |
| 131. | Headlights, sand boxes, bells, and whistles. | 165. | Hydrostatic test. |
| | | 166. | Test of rigid and hollow staybolts. |
| | | 167. | Staybolts with caps. |
| | | 168. | Flexible staybolts without caps. |

Rule No.

- 169. Broken staybolts.
- 170. Telltale holes.
- 171. Pressure gauge.
- 172. Safety valves.
- 173. Water glass and gauge cocks.
- 174. Feedwater appliances.
- 175. Water tubes.
- 176. Boiler washing.
- 177. Leaks.
- 178. Feedwater tanks and strainers.

Rule No.

- 179. Fuel tanks and piping.
- 180. Feedwater and fuel oil reservoir testing.
- 181. Boiler and reservoir fastenings.
- 182. Steam headers.
- 183. Oil-burning fireboxes.

8. REPORTS

- 184. Filing reports.
- 185. Accident reports.

INDEX

	<i>Paragraph</i>	<i>Page</i>		<i>Paragraph</i>	<i>Page</i>
Air compressor and brakes, steam locomotive	70	22	Firing, steam locomotives	64	18
Alteration Report	209	71	Forms, operating and inspection reports....	205-226	71
Annual Inspection and Repair Report.....	214, 216	79, 88	Alteration Report	209	71
Ashpan Inspection and Repair Record.....	208	71	Annual Inspection and Repair Report..	216	88
Auto-Railers:			Ashpan Inspection and Repair Record..	208	71
General	201	68	Boiler and Tender Tank Washout Record	218	92
Maintenance	202	68	Boiler Specification Card	210	78
Operation	202	68	Broken Staybolt Report	221	93
Types	203	68	Daily Assignment Work Sheet	206	71
Boiler maintenance, steam locomotives.....	67	21	Daily Inspection Report	213	79
Boiler and Tender Tank Washout Record..	218	92	Derrick Operating and Inspection Forms	224	93
Boiler Specification Card	210	78	General	205	71
Brakes and air compressor, steam locomotives	70	22	Inspection, Cleaning and Test Record..	219	92
Broken Staybolt Report	221	93	Instructions for Monthly and Annual		
Cranes, locomotive	189	60	Reports	214	79
Oversea shipment	192	62	Locomotive Crane Operating and Inspec-		
Daily Assignment Work Sheet	206	71	tion Forms	224	93
Daily Inspection Report	213	79	Locomotive Equipment Supply and Tool		
Derrick Operating and Inspection Form....	224	93	List	211	78
Derricks:			Maintenance and Inspection Chart.....	207	71
Maintenance	188-192	60	Monthly Condition Report	222	93
Operation	188-192	60	Monthly Inspection and Repair Report		
Oversea shipment	192	62	for Steam Locomotives and Locomo-		
Diesel-electric locomotives:			tive Cranes	215	85
Inspection	178-183	57	Monthly Inspection and Repair Report		
Maintenance	169-177	54	of Locomotives and Locomotive		
Movement "dead-on-wheels"	184	58	Cranes, other than Steam.....	217	90
Ocean-transit preparation	185	58	Pile Driver Operating and Inspection		
Operation	147-168	50	Form	224	93
Operation after storage.....	187	59	Record of Repairs	206	71
Preliminary instructions	146	50	Requisitioning Forms	226	93
Storage preparation	186	58	Territorial Departments and Commands	225	93
Electric headlight dynamo	71	23	Spark Arrester Inspection and Repair		
Feedwater control, steam locomotives.....	66	20	Record	208	71
			Steam Locomotive and Internal Combus-		
			tion Locomotive Specification Card..	220	93
			Unsatisfactory Equipment Report.....	223	93
			Weekly Shop Report of Railroad Equip-		
			ment	212	78
			Gasoline-mechanical locomotives:		
			General	194	65
			Inspection	198	66
			Maintenance	199	66

	<i>Paragraph</i>	<i>Page</i>		<i>Paragraph</i>	<i>Page</i>
Ocean-transit preparation	200	67	Monthly inspection and repair reports.....	215, 217	85, 90
Operation	195	65	Movement "dead-on-wheels":		
Precautions	196	65	Diesel-electric locomotives	184	58
Trouble shooting	197	66	Steam locomotives	74	26
Hoisting slings	193	62	Ocean-transit preparation:		
Inspection, Cleaning and Test Record.....	219	92	Diesel-electric locomotives	185	58
Inspection:			Gasoline-mechanical locomotives	200	67
Diesel-electric locomotives	178-183	57	Steam locomotives	75	27
Gasoline-mechanical locomotives	198	66	Operation after storage, Diesel-electric loco-		
Steam locomotives	72	24	motives	187	59
Inspection and Operating Report Forms....	205-226	71	Operation and maintenance:		
Inspection and testing:			Auto-railers	201-203	68
Other than steam locomotives.....	77-144	28	Diesel-electric locomotives	145-187	49
Steam locomotives	14-61	6	Gasoline-mechanical locomotives	194-200	65
Instructions:			Locomotive cranes, derricks, pile-drivers.....	188-193	60
General	1-6	1	Steam locomotives	62-76	17
Monthly and annual report.....	214	79	Oversea shipment:		
Preliminary for Diesel-electric loco-	146	49	Derricks	192	62
tives			Locomotive cranes	192	62
Lay-over care, steam locomotives.....	76	27	Pile-drivers	192	62
Lettering and repainting, surface maintenance	204	70	Painting	204	70
Locomotive Equipment Supply and Tool List	211	78	Pile drivers:		
Locomotive cranes, derricks, pile drivers—			Maintenance	190	61
operation and maintenance	188-193	60	Operation	190	61
Locomotive cranes:			Oversea shipment	192	62
Maintenance of	189	60	Pile Drivers Operating and Inspection Form.	224	93
Operating and inspection forms.....	224	93	Preliminary instructions, Diesel-electric loco-		
Operation	189	60	motives	146	49
Oversea shipment	192	62	Preparation for ocean-transit:		
Lubrication, steam locomotives	5, 69	2, 22	Diesel-electric locomotives	185	58
Machinery maintenance, steam locomotives..	68	22	Gasoline-mechanical locomotives	200	67
Maintenance and Inspection Chart.....	207	71	Steam locomotives	75	27
Maintenance:			Record of Repairs	206	71
Boiler	67	21	Regulations, inspection and testing:		
Echelons	8-12	3	Other than steam locomotives	77-144	28
General	7	3	Steam locomotives	14-61	6
Gasoline-mechanical locomotives	199	66	Repainting and lettering, surface maintenance	204	70
Steam locomotive machinery	68	22	Reports, operating and inspection forms....	205-226	71
Surface-repainting and lettering.....	204	70	Responsibility, general	4	1
Maintenance and operation:			Requisitioning forms	226	93
Auto-railers	201-203	68	Safety:		
Diesel-electric locomotives	145-187	49	General	6	2
Gasoline-mechanical locomotives.....	194-200	65	Precautions, steam locomotives	65	20
Locomotive cranes, derricks, pile-drivers.....	188-193	60	Slings, hoisting	193	62
Steam locomotives	62-76	17	Spark Arrester, Inspection and Repair Record	208	71
Monthly Condition Report	222	93	Steam Internal Combustion Locomotive		
			Specification Card	220	93

	<i>Paragraph</i>	<i>Page</i>		<i>Paragraph</i>	<i>Page</i>
Steam locomotives:			Storage preparation	73	25
Air compressor and brakes.....	70	22	Storage preparation:		
Boiler maintenance	67	21	Diesel-electric locomotives	186	58
Feedwater control	66	20	Steam locomotives	73	25
Firing	64	18	Surface maintenance, repainting and lettering	204	70
Inspection	72	24	Testing and inspection:		
Inspection and testing regulations.....	14-61	6	Other than steam locomotives	77-144	28
Lay-over care	76	27	Steam locomotives	14-61	6
Lubrication	69	22	Trouble shooting, gasoline-mechanical loco-		
Machinery maintenance	68	22	motives	197	66
Movement "dead-on-wheels"	74	26	Water treatment	13	5
Operation and maintenance.....	62-76	17			
Preparation for ocean-transit	75	27			
Specification card	220	93			

UNIVERSITY OF MICHIGAN

3 9015 02015 8062

Transp.	U.S. War Dept.
TJ	Operation of railroads;
685	general instructions for
.U58	the inspection and main-
1945	tenance of locomotives
	and locomotive cranes.

DATE DUE			